2nd Edition

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The 2nd International Conference on Smart Materials & Surfaces

SMS Korea 2016

23 - 25 March, 2016

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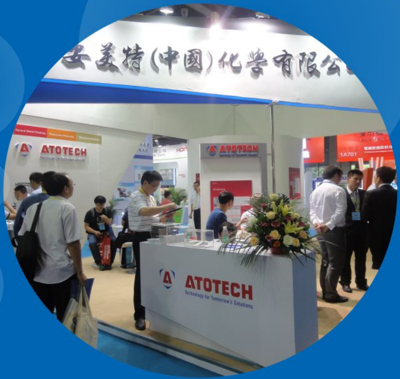

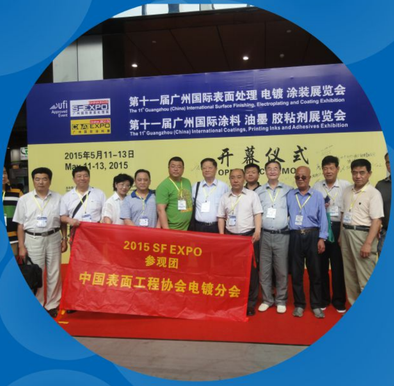

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Smart Materials and Surfaces - SMS Korea 2016
Conference Program

March 23rd, 2016

Session I: Smart Materials and surfaces design, formulation and processing

Conference Room 113/114

Session Chairs: Prof. Nicole Demarquette, Ecole de Technologie Superieure Montreal, **Canada**
Prof. Mohabattul Zaman Bukhari, Malaysia Perlis University, **Malaysia**

08:00-09:30	**Registration**	
09:30-10:15	Development of High-Strength Carbon Nanotube Fibers A.Jung, H.J.Kim, J.Lee, Y.-O.Im, S.-H. Lee and K.-H.Lee	**Prof Kun-Hong Lee**, Pohang University of Science and Technology, **Rep. of Korea**
10:15-10:45	**Coffee Break / Posters Session**	
10:45-11:15	Synthesis, Characterization and Application of a New Form of Three-Dimensional Graphene **V. Shanov**, L. Zhang, N. Alvarez, M. Zhang,M. Haase, R. Malik and D. Mast	**Dr. Vesselin Shanov**, University of Cincinnati, **USA**
11:15-11:45	Fabrication of carbon fiber-oriented Al-C composite and investigation of its thermal conductivity **T. Tokunaga**, K. Takahashi, K. Matsuura, M. Ohno, K. Sasaki and T. Imanishi	**Dr Toko Tokunaga**, Hokkaido University, **Japan**
11:45-12:00	Synthesis of low-temperature radio frequency plasma enhanced chemical vapour deposition transfer-free graphene **M. Othman**, R. Ritikos, N.H.Khanis, N. M. A. Rashid and S. A. Rahman	**Mrs. Maisara Othman**, University of Malaya, **Malaysia**
12:00-12:15	Wafer-scale single-crystalline-like polycrystalline graphene with ZnO stitching **B. Cho** and M.M. Sung	**Mr. Boram Cho**, Hanyang University, **Rep. of Korea**
12:15-12:30	A New Series of Porous Lanthanide-2,6-Pyridinedicarboxylate Frameworks: Synthesis, Structures and Photoluminescence Properties **T.Chuasaard**, P. Rodlamul and A. Rujiwatra	**Mr. Thammanoon Chuasaard**, Chiang Mai University,**Thailand**
12:30-12:45	Synthesis of Zinc Oxide Crystal Scaffolds with Strong Near Band Edge Emissions **S.K.Sharma** and R.Jagannathan	**Dr Sudhir Kumar Sharma**, New York University Abu Dhabi, **UAE**
12:30-14:00	**Break / Posters Session**	

Conference Room 113

Session Chairs: Dr. Vesselin Shanov, University of Cincinnati, **USA**

14:00-14:30	Signal Amplification in Polymeric Materials Using Self-Propagating Responses and Continuous Head-To-Tail Depolymerization **Hyungwoo Kim** and Scott T. Phillips	**Dr Hyungwoo Kim,** Pennsylvania State University, **USA**
14:30-15:00	Dielectric properties of novel lead-free Polyvinylidenefluoride-trifluoroethylene-$Bi_{0.5}Na_{0.5}TiO_3$ nanocomposite thin films R.I. Mahdi, W.C.Gan, N.A.Halim, T.S.Velayutham and **W.H.Abd.Majid**	**Prof. Wan Haliza Abd. Majid**, University Malaya**, Malaysia**
15:00-15:15	Effect of Sc and Heat treatment on the microstructure and mechanical properties of A356 Aluminium alloy A. Masita, **Y. P. Lim** and W. H. Yeo	**Dr Lim Ying Pio**, Universiti Tunku Abdul Rahman, **Malaysia**
15:15-15:30	Dry ice blasting as a substitution for conventional electroplating pre-treatment processes E. Uhlmann, E. M. Baira and R. Jaczkowski	**Mr. El Mustapha Baira**, Institute for Machine Tools and Factory Management, Technische Universität, Berlin, **Germany**

15:30-15:45	Effect of processing parameters on the morphology and wetting of electrospun mats **R. Kurusu** and N. Demarquette	**Mr. Rafael Kurusu**, École de Technologie Supérieure, **Canada**
15:45-16:00	Low-temperature plasma modification of fillers for advanced polymer composites M. Sicinski	**Dr Mariusz Sicinski**, Lodz University of Technology, **Poland**
16:00-16:30	**Coffee Break / Posters Session**	
16:30-16:45	The Square-Wave Galvanostatic Pulsed Co-electrodeposition of Ni-Zn Alloy on Steel Substrate: Effect of Duty Cycles **P. Kamnerdkhag** and A.Rodchanarowan	**Mr. Parunyoo Kamnerdkhag**, Kasetsart University, **Thailand**

Conference Room 114

Session Chairs: Dr Toko Tokunaga, Hokkaido University, **Japan**
Prof Taleb H. Ibrahim, American University of Sharjah, **UAE**

14:00-14:30	Smart Materials Analysis as a Medium of Protection in Aircraft Fuselage I.R.W Perdana**,** A.A Al-Hadi and **M.Z Bukhari**	**Prof. Mohabattul Zaman Bukhari**, Malaysia Perlis University- **Malaysia**
14:30-14:45	Highly Stable Water-Soluble Platinum Nanoparticles Stabilized by Hydrophilic N-Heterocyclic Carbenes **E. A. Baquero**, S. Tricard, Y. Coppel, J. C. Flores, E. de Jesús B. Chaudret	**Dr Edwin Arley Baquero Velasco**, INSA Toulouse, **France**
14:45-15:00	New ColoredZinc Borophosphate Glasses **C. Tupberg** and C. Randorn	**Mr. Chayopas Tupberg**, Chiang Mai University**, Thailand**
15:00-15:15	Tailored chemically patterned surfaces for the control of the frictional behavior at polymer-polymer interfaces **I. Ben Ali**, G. Pallares, P. Cassagnau, J. Scheibert and S. Al Akhrass	**Mr Imed Eddine Ben Ali**, Claude-Bernard Lyon 1 University, **France**
15:15-15:30	Carbon nanowalls prepared by home-built plasma assisted hot wire chemical vapor deposition **N. H. Khanis**, R. Ritikos,N. M. A. Rashid, M. Othman, W. S. Chiuand S. A. Rahman	**Mrs. Noor Hamizah Khanis**, University of Malaya, **Malaysia**
15:30-15:45	The Wear Behavior of Al7075-T651 Coated with Micro Arc Oxidation Method **M. E. Özcan,** L. Özler and E.E.Sukuroglu	**Mr. Mehmet Erbil Ozcan**, Fırat University- **Turkey**
15:45-16:00	Fabrication of self-healing porous concrete to eliminate failure caused by alkaline-silica reaction (ASR) **N.Jaroonvechatam**, T.Meesak, S. Sujjavanich and O. Jongprateep	**Ms. Napamas Jaroonvechatam**, Kasetsart University- **Thailand**
16:00-16:30	**Coffee Break / Posters Session**	
16:30-16:45	Subsolidus phase equilibria and electrical properties of pyrochlores in the Bi_2O_3-CuO-Ta_2O_5 ternary system M. P. Chon, **K. B. Tan**, C. C. Khaw, Z. Zainal, Y. H. Taufiq-Yap, S. K. Chen and P.Y. Tan	**Dr. Kar Ban Tan**, Putra University Malaysia- **Malaysia**

March 24th , 2016

Session II: Smart Materials for Energy Harvesting and storage / Environment / Electronics

Conference Room 113/114

Session Chairs: Prof. Elias Siores, Bolton University, **United Kingdom**
Dr. Vesselin Shanov, University of Cincinnati, **USA**

09:00-9:45	Smart Functional Materials for energy: from laboratory to commercialization **E. Siores**	**Prof. Elias Siores**, Bolton University, **United Kingdom**
09:45-10:30	Tunability and piezoelectric properties of $Ba_{1-x}Ca_xTi_{1-y}Zr_yO_3$ based thin film capacitors C.J.M. Daumont, Q. Simon, S. Paya, J.L. Longuet, B. Negulescu, M. Maglione and **J. Wolfman**	**Dr. Jerome Wolfman**, Tours University- CNRS, **France**
10:30-11:00	**Coffee Break / Posters Session**	
11:00-11:30	Ultra-high mobility graphene through support-layer engineering Ya-Ping Hsieh, Mario Hofmann and Jhin-Lun Kuo	**Mr. Jhin-Lun Kuo**, National Chung Cheng university, **Taiwan**
11:30-11:45	Strategy towards alignment of conjugated polymer chain for high-mobility transistors **A.K.K Kyaw**	**Dr Aung Ko Ko Kyaw**, Institute of Materials Research and Engineering, **Singapore**
11:45-12:00	Terahertz magneto-absorption and faraday rotation in electrostatically control graphene and graphene anti-dot **J. M. Poumirol**, P. Q. Liu, J. Faist and A. B. Kuzmenko	**Dr. Jean-Marie Poumirol**, University of Geneva, **Switzerland**
12:00-12:15	Enhanced carrier transport in ad-layer-covered graphene Ya-Ping Hsieh, Mario Hofmann and **Ting-Wei Chen**	**Mr. Ting-Wei Chen**, National Chung Cheng University, **Taiwan**
12:15-12:30	Surface Engineering of Pt submonolayer on Au Nanostruc-ture by ion adsorption-in situ electrochemical reduction for Fuel Cell Application **K-F. Yung**	**Dr Ka-Fu Yung**, The Hong Kong Polytechnic University, **Hong Kong**
12:30-14:00	**Lunch Break / Posters Session**	

Conference Room 113

Session chairs: Dr. Jerome Wolfman, Tours University, CNRS- **France**
Prof. Elias Siores, Bolton University, **United Kingdom**
Prof. Nicolas Voelcker, University of South Australia, **Australia**

14:00-14:15	Fabrication and Structural Optimization of Porous Single-crystal α-Fe2O3 Microrices for High-Performance Lithium-ion Battery Anode **B. Yu** and Z. Ren	**Mr. Bao Zhi Yu**, Northwest University, **China**
14:15- 14:30	Nanoelectrode Array Formation by Electrolytic Nanoparticle Impacts **T.R.Bartlett**, S.V. Sokolov, J.Holter, N. Young and R. G. Compto	**Mr. Thomas Bartlett**, University Of Oxford, **United Kingdom**
14:30-14:45	ZnFe2O4 nanoparticles synthesis by laser pyrolysis: interest as new anode material for lithium-ion batteries **S.Bourrioux**, L.P.Wang, Y.Leconte, M.Srinivasan, Z.J. Xu and A.Pasturel	**Ms Samantha Bourrioux**, CEA Saclay, **France**
14:45-15:15	Synthesis of Binder free Graphene@MnO2/PANI nanocompsite for electrode material in high performance supercapacitors **M. Asif**, T. Yi, L. Pan and M. Rashad	**Dr. Muhammad Asif**, Dalian University of Technology, **China**
15:15-15:30	Scalable production of graphene with adjustable electronic properties by electrochemical intercalation and exfoliation Y. Hsieh, M. Hofmann and **W. Chiang**	**Ms. Wan-Yu Chiang**, National Chung Cheng University, **Taiwan**
15.30-15:45	Pyroelectric, ferroelectric, piezoelectric and dielectric properties of Na0.5Bi0.5TiO3ceramic processed by sol-gel method N.A. Halim, T.S. Velayutham, W.H. Abd. Majid	**Mrs. Nurain Ab. Halim**, University of Malaya, **Malaysia**

15:45-16:00	ZnO-based UV detector performance improvement **Khakhulin D.A.** , Jong-Gul Yoon, Ageev O.A., Zamburg E.G., Varzarev Yu.N.	**Mr. Daniil Khakhulin**, Southern Federal University, **Russia**
16:00-16:30	**Coffee Break / Posters Session**	
16:30-16:45	Quaternized Polyphenylene oxide/TiO2 anionic composite membranes for application in alkaline polymer electrolyte fuel cells **P.Msomi**, P.Nonjola and J.Ramotja	**Mr. Phumlani Msomi**, University of Johannesburg, **South Africa**

Conference Room 114

Session chairs: Dr Hyungwoo Kim, Pennsylvania State University, **USA**

14:00-14:30	Oil Removal from Produced Oil Using Graphene **T.H. Ibrahim**, L. AbouChacra, M. Khamis and Y.ElSayed	**Prof Taleb H. Ibrahim**, American University of Sharjah, **United Arab Emirates**
14:30-14:45	Humidity Sensing Investigation of Copper-Palladium Nano-structures **A.K.Jaiswal** and R.R. Yadav	**Mr Aashit Kumar Jaiswal,** Univeristy of Allahabad, **India**
14:45-15:00	Smart Heat Absorbers based on Phase Change Materials for Energy Storage in Bioclimatic Buildings **H. Abdelrazeq**, I. Krupa, M. Al-Maadeed, A.S. Luyt, M. Ouederni and I. Belharouak	**Ms. Haneen Abdelrazeq**, Qatar University, **Qatar**
15:00-15:15	Gas Sorption Kinetics in the Confined Space of Nano-Pores of Metal-Organic Frameworks **L. Li** and X.Zhao	**Dr Liangjun Li**, China University of Petroleum (East China), **China**
15:15-15:30	Effect of pH on Adsorption Capabilities and Magnetic Properties of MnFe2O4 Nanoparticles for Removal of Dye Pollutants **U.Lamdab**, K.Wetchakun, S.Phanichphant, W.Kangwansupamonkon and N. Wetchakun	**Ms. Umaporn Lamdab**, Chiang Mai University, **Thailand**
15.30-15:45	Fabrication of ZnWO4/Bi2WO6 Composite Films as Efficient Photocatalyst for Degradation of Dye Pollutants S. Issarapanacheewin, K. Wetchakun, S. Phanichphant, W. Kangwansupamonkon and **N. Wetchakul**	**Ms.Sudarat Issarapanacheewin**, Chiang Mai University, **Thailand**
15:45-16:00	Ultrathin Mussel-inspired Solvent Resistant Nanofiltration Membranes **L. Pérez-Manríquez**, A.R Bezhad and K-V. Peinemann	**Ms. Liliana Perez-Manriquez**, King Abdullah University of Science and Technology, **Saudi Arabia**
16:00-16:30	**Coffee Break / Posters Session**	
16:30-16:45	Increasing the volume fraction of La(Fe,Si)$_{13}$ phase inLa-Fe-Si magnetocaloric alloys by directional solidification **L. Yang**,Y.Huang and J.Li	**Mr Liang Yang,** Shanghai Jiao Tong University- **China**

March 25th , 2016

Session III: Smart Materials for Bio-applications

Conference Room 113/114

Session chairs: Dr. Joo Eun Chung, Institute of bioengineering and Nanotechnology, **Singapore**
Prof. Nicolas Voelcker, University of South Australia, **Australia**

09:00-9:45	Targeted Drug Delivery to Brain Tumours Using Porous Silicon Nanoparticles **N.H. Voelcker**	**Prof. Nicolas Voelcker**, University of South Australia, **Australia**
09:45-10:30	Organic/Graphene Based Nanomaterials and Nanodevices **K.S. Kim**	**Prof Kwang S. Kim**, Ulsan National Institute of Science and Technology, **Rep. of Korea**
10:30-11:00	**Coffee Break**	
11:00-11:30	Green Tea-Sourced Micellar Nanocomplex for Protein Delivery that Achieves Synergistic Effects **J.E. Chung,** S. Tan, S;J. Gao, N. Yongvosoontorn, M.Kurisawa and J.Y. Ying	**Dr. Joo Eun Chung**, Institute of bioengineering and Nanotechnology, **Singapore**
11:30-11:45	Graphene/Polymer Nanocomposites Modified Substrates for Sensitive Biomolecular Detection **N.Rodthongkum**, R.W. Vachet and O. Chailapakul	**Dr Nadnudda Rodthongkum**, Chulalongkorn University, **Thailand**
11:45-12:00	Effects of Synthesis Techniques and Initial Reagents on Chemical Compositions and Microstructure of Hydroxyapatite **J. Palomas** and O.Jongprateep	**Mr. Jednupong Palomas**, Kasetsart University, **Thailand**
12:00-12:15	Effect of calcium from eggshell addition on bioactivity properties of metakaolin/calcium hydroxide blended geopolymer **C.Tippayasam**, K.Amornratthamrong, T.Padthamkul, P.Thavorniti, P.Chindaprasirt and D.Chaysuwan	**Ms. Chayanee Tippayasam**, Kasetsart University, **Thailand**
12:15-12:30	Dendrimer mediated bioadhesion of PLGA to soft tissues. **Gao Feng,** Vishal Mogal, Richard O'Rorke, Ivan Djordjevic and Terry W. J. Steele	**Mr. Gao Feng**, Nanyang Technological Univerisity, **Singapore**
12:30-12:45	pEDOT:Vitamin K composites: proton bonding conducting polymer +quinoid thin film electrodes **D. Mayevsky** and B.Winther-Jensen	**Mr. David Mayevsky**, Monash University, **Australia**
12:45-13:00	Non and Woven flax Fiber for use in reinforced poly(butylene Adipate-coterephalate) biocomposites. **S. Siengchin**, P. Boonyasopon and R. Srisuk	**Professor. Suchart Siengchin**, King Mongkut's University of Technology North Bangkok, **Thailand**
13:00-13:15	Stress Analysis of Long fractures on human leg bone combined with internal fxation **S. Erdem**, M.Gur and M.O. Kaman	**Mr Serkan Erdem**, Fırat University, **Turkey**
13:15-13:45	**Closing Ceremony**	

Posters Session, March 23rd and 24th, 2016

Conference Room 115

N.	Title	Author/Affiliation/Country
1	Investigation of ionic liquid based-carboxymethyl cellulose biopolymer electrolytes for potential application in electrochemical devices **M.S.A. Rani**, A. Ahmad and N.S. Mohamed	**Mr Mohd Saiful Asmal Rani**, University of Malaya, **Malaysia**
2	Highly Efficient Carbon-nanotube/Platinum Based Microrockets **R. Dong** and B.Ren	**Mr. Renfeng Dong**, South China University of Technology, **China**
3	Rapid Heat Treatment Synthesis of Reduced Graphene Oxide Uniformly Decorated with Nickel Oxide Nanoparticles for Antioxidant Activities **A.M. Noor** and H.N. Ming	**Mr. An amt Mohamed Noor**, University of Malaya, **Malaysia**
4	Solution-processable Low-bandgap 3-Fluorothieno[3,4-b]thiophene-2-carboxylate-based Conjugated Polymers for Electrochromic Applications **Zugui Shi**, Wei Teng Neo, Ting Ting Lin, Hui Zhoua and Jianwei Xua	**Dr. Zugui Shi**, Institute of Materials Research and Engineering, **Singapore**
5	Co3O4/nitrogen-doped graphene/carbon nanotubes: An innovative ternary composite with enhanced electrochemical performance **Z. Ren** and B. Yu	**Professor. Zhao Yu Ren**, Northwest University, **China**
6	Synthesis of 57Co diffused Rh composite for application of Mössbauer source **Y.Rang Uhm**, S.M. Choi and M.G. Hur	**Dr. Young Rang Uhm**, Korea Atomic Energy Research Institute (KAERI), **Rep. of Korea**
7	Structural Characteristics of Rolled-up Si Micro/nanotubes Prepared by Anodization **T.Shimizu**, T.Suzuki, M. Niwa and M.Motohashi	**Mr. Tomoki Shimizu**, Tokyo Denki University, **Japan**
8	Synthesis of Nanoparticulate Ti-doped ZnO by Solution Combustion Technique O.Jongprateep, **P.Deedit** and R.Puranasamriddhi	**Ms Pathitta Deedit**, Kasetsart University, **Thailand**
9	Single Crystalline Hematite (α-Fe2O3) Nanocubes Prepared by One-Pot Hydrothermal Approach: The Structural and Optical Properties **N.M.A.Rashid**, W.S. Chiu, C.Y. Haw, N.H.Khanis, A.Rohaizad, P.S.Khiew and S.A. Rahman	**Ms. Nur Maisarah Abdul Rashid**, University of Malaya, **Malaysia**
10	Preparation of self-cleaning TiO2/SiO2 double layer thin films by sol-gel method **H.M. Yadav**, B-M. Kim and J-S. Kim	**Dr. Hemraj Yadav**, University of Seoul**, Rep. of Korea**
11	Ni-Ti Shape Memory Alloy Sheet Part Stretch Formed at Room Temperature **K.-J. Fann** and J.-Y. Su	**Prof. Kuang-Jau Fann,** National Chung Hsing University, **Taiwan**
12	Titanate Nanobelts Modified by Metal Intercalation for Photovoltaic Applications **C-T.Wang**, Y-C.Han and J-K. Jhang	**Prof Chien-Tsung Wang** National Yunlin University of Science and Technology, **Taiwan**
13	Graphene-Based Nano Materials Development for Thermal Insulation Applications **S.A.Mofid**, B.P. Jelle and T.Gao	**Mr Sohrab Alex Mofid**, Norwegian University of Science and Technology (NTNU), **Norway**
14	Improvement in Ni (II) adsorption capacity by using Fe-nano zeolite **P-T. Huong**, **B-K. Lee**, J. Kim and C-H. Lee	**Ms Pham-Thi Huong**, University of Ulsan, **Rep. of Korea**
15	Enhancement of CO_2 capture by using synthesized Cu-nano-zeolite **P-T. Huong**, **B-K. Lee**, C-H. Lee and J. Kim	**Prof. Byeong- kyu Lee**, University of Ulsan, **Republic of Korea**
16	Facile Preparation of Hexagonal Tungsten Oxide Nanoflowers: Their Characterization and Probability of Optical and Electrochemical Detection of H_2O_2 **C.Y.Park**, J.M.Seo, H.Ill Jo, J.H. Park, K.M. Ok and T.J. Park	**Mr. Chan Yeong Park**, Chung-Ang University, **Rep. of Korea**

17	Novel Donor-Acceptor Conjugated Polymers with Tunable Hues for Electrochromic Displays **W.T.Neo** and J. Xu	**Ms. Wei Teng Neo**, Institute of Materials Research and Engineering, **Singapore**
18	Frequency Study of the Polymer Coated SAW Micro-sensor to the Chemical Agent Simulant **B.Seo**, J.H. Kim and Y-J. Lee	**Dr Seo Byung-il**, Agency for Defense Dvelоment-Inha Univesity, **Rep. of Korea**
19	SnO2-ZnO-CuO multilayerd sensor structure for H2S detecting **M. Sarfi**, M.ghadimi ,A. Babaee	**Mr. Mohammad Hossein Sarfi**, Mofid High School, Tehran, **Iran**
20	Proton Beam Writing (PBW) of Polymeric Micro-cantilever based RF-MEMS switch **S. Al-Shehri**, V. Palitsin, R.P. Webb and G.W. Grime	**Dr. Saad Alshehri**, University of Surrey, **United Kingdom**
21	Novel Pyrrolophthalazine dione-Based Conjugated Polymers for Electrochromic Applications W.T. Neoa, **Q.Ye** and J.Xu	**Dr. Qun Ye**, Institute of Materials Research and Engineering, Agency for Science, Technology and Research (A*STAR), **Singapore**
22	Synthesis of Ultrahighly Electron-Deficient Pyrrolo[3,4-d]pyridazine-5,7-dione by Inverse Electron Demand Diels–Alder Reaction and Its Application as Electrochromic Materials **H.Zeng**, Q. Ye and J. Xu	**Dr. Huining Zeng**, Institute of Materials Research and Engineering, Agency for Science, Research and Engineering (A*STAR), **Singapore**
23	TiO2 Nanorod thin films embedded with Gold nanoparticles for enhanced photocatalytic activity **D.Raval**, I. Mukhopadhyay and A. Ray	**Mr. Dhyey Raval**, Pandit Deendayal Petroleum University, **India**
24	Fabrication, Characterization and Gas Sensing of Cobalt Antimony Oxide Nanospheres Prepared via Sol-Gel Method **A. Singh** and P.Tandon	**Mr Ajendra Singh,** University of Lucknow, **India**
25	Fabrication of Heterostructure of 3-D Photonic Crystals of Polystyrene Microspheres by Self-Assembly Routes D. Liao, M.Tsai, K. Tsai and **R-F.Louh**	**Dr. Louh Rong-Fuh**, Feng Chia University, **Taiwan**
26	Influence of eplating formulations on microstructure and corrosion resistance of electrodeposited zinc coatings **K.Saengkiettiyut**, P.Rattanawaleedirojn, A.Thueploy, J.Wanichsampan and Y.Boonyongmaneerat	**Ms. Kanokwan Saengkiettiyut**, Chulalongkorn University, Bangkok, **Thailand**
27	Silver Nanoparticles Inkjet Printing on Polyurethane Nano-fiber for Water Purification Application **S.J. Lee**, M. Heo, N. Su A Park and Il Keun Kwon	**Mr. Sang Jin Lee**, Kyung Hee University, **Rep. of Korea**
28	Development of CT/NIRF Dual Imaging Probe to Detect Thrombosis **S.H. Lee**, S-H. Lee, I-C. Sun, J-Y. Kim, D-E. Kim, , K. Kim and C-H. Ahn	**Mr. Seon Ho Lee**, Seoul National University, **Rep. of Korea**
29	Acrylate copolymers containing urushiol as the active com-pound for antibacterial and antifouling application. **N. Lone** and J.Joo	**Ms. Nasreena Lone**, Kyungpook National University, **Rep. of Korea**
30	Core-shell structured upconversion luminescent nanocomposites conjugated with graphene oxide quantum dots for photodynamic therapy **S.H.Baek**, S.Y. Choi and T.J. Park	**Mr. Baek Seung Hoon**, Chung-Ang University, **Rep. of Korea**
31	Nanographene-Coated Double Nanoemulsion for Image-Monitored Controlled Drug Delivery X.He, V.Shanov and **Y.Park**	**Dr. Yoonjee Park**, University of Cincinnati, **USA**
32	Direct synthesis of vertically standing graphene film on various substrates by electron cyclotron resonance plasma **Jin-ha Shin**, HyunJae Park, Yong-ho Jung, Yong-sup Choi, Young Il Song, Su Jeong Suh	**Mr Jin-ha Shin**, Sungkyunkwan University, **Korea**

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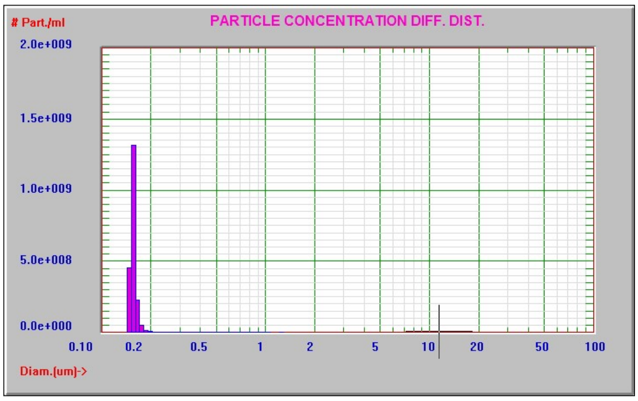

Applications

- Pharmaceutical Injectables
- Nano Particles
- Inks, Pigments
- Emulsions
- Dispersions
- Stability Analysis
- Ceramics / Abrasives
- Polymers

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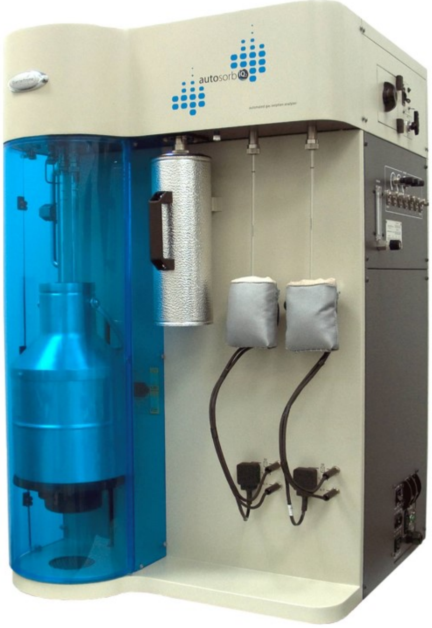

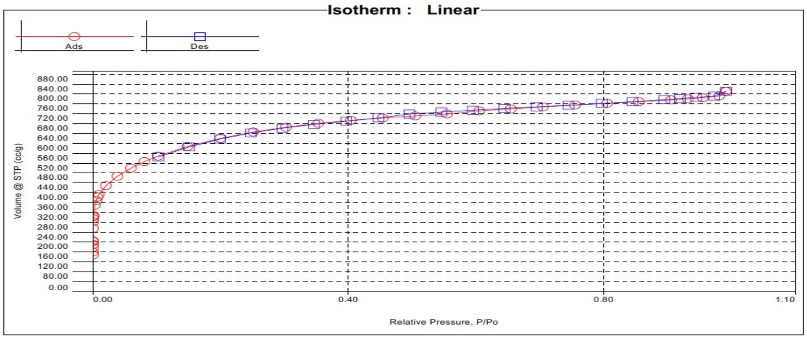

- Coolant level controlled
- TCD, Mass spectrometer
- CryoCooler
- Calorimeter interface
- QSDFT plot

Applications

- Pharmacy
- Carbon
- Catalysts
- Ceramics
- Energy

Session I:
Smart Materials and surfaces design, formulation and processing

Development of High-Strength Carbon Nanotube Fibers

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Abstract:
CNT fibers are composed of axially aligned and highly packed CNTs. The tensile strengths of CNT fibers, however, have been reported much lower than those of individual CNTs. In our laboratory, two measures were introduced to increase the tensile strengths of CNT fibers. First, highly compacted CNT fibers were produced. Secondly, CNTs in a CNT fiber were cross-linked to increase the bonding between CNTs. Mechanical measurements showed that the tensile strengths of CNT fibers were dramatically increased after these measures. In addition to these, a technique to synthesize high quality CNTs was investigated. It was revealed that sulfur and hydrogen played key roles on the quality of synthesized CNTs. A model for the interplay between sulfur atoms and the iron catalyst particles was proposed based on these results, and this model was experimentally confirmed by modulating the sulfur injection time into the reactor at different temperatures.

Keywords: carbon nanotube, CNT fiber, elastocapillary effect, covalent bonding, sulfur effect

Synthesis, Characterization and Application of a New Form of Three-Dimensional Graphene

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Abstract:

Chemical Vapor Deposition (CVD) of 2-dimensional (2D) graphene has been extensively studied. Less attention has been paid on fabrication and characterization of 3D graphene structures. Here, we report synthesis of a novel 3D graphene body called graphene pellet (GP) and making use of it by fabricating graphene paper (Zhang *et al.*; 2015). Graphene pellet was synthesized by CVD, using pre-shaped cylinders of nickel particles with defined grain size. This porous metal body served as a catalyst and produced 3D graphene when exposed to a gas mixture of methane, hydrogen and argon at 1000˚C. The obtained graphene pellet was processed by acid for removing the remaining nickel catalyst. This procedure yielded almost 100% pure 3D graphene structure which was characterized by Scanning Electron Microscopy (Figure 1), Inductively Coupled Plasma (ICP) Analysis, Raman spectroscopy and 4 probe electrical measurements. Further, the obtained 3D graphene was converted into a thin graphene paper by pressing. The paper exhibits a breaking stress at 22 ± 1.4 MPa and a high electrical conductivity of up to 1136 ± 32 S cm^{-1}. The manufactured graphene paper preserves the 3D structure of its building blocks. Paper with thickness of 50 µm revealed 60 dB electromagnetic interference (EMI) shielding effectiveness, which makes it a promising shielding material. Another application of the 3D graphene that will be illustrated is fabrication of electrodes for supercapacitors. Data related to the performance of such an energy storage devise will be also presented. Two of the fabricated coin cell supercapacitors can easily power a light emitting diod (Figure 2).

Keywords: CVD, 3D graphene, graphene paper, electrical and mechanical properties of 3D graphene, EMI shielding application, energy storage application, supercapacitor, electrochemical characteristics of 3D graphene based supercapacitor.

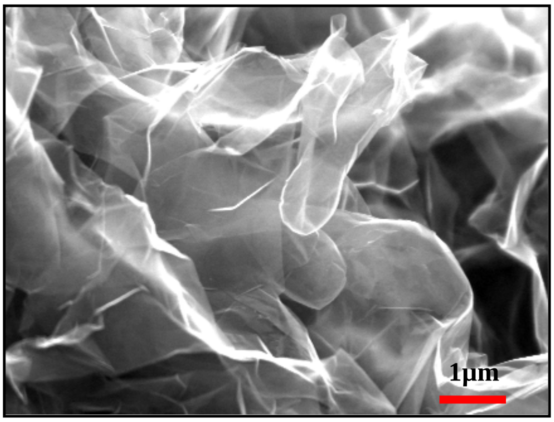

Figure 1: Fig. 1. SEM Image of 3D Graphene

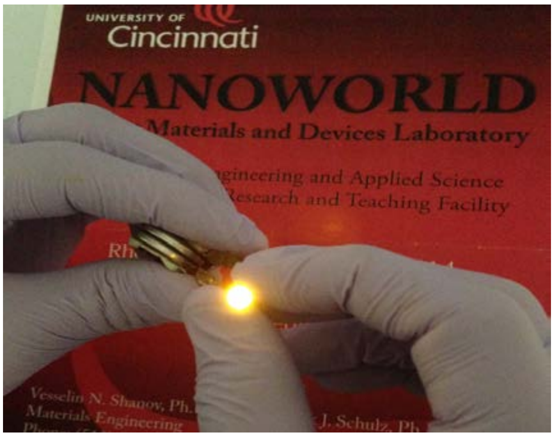

Figure 2. A two stacked GP/MnO_2/Polypyrrole electrochemical capacitors fabricated based on this work powering an LED. All the electrochemical tests were conducted in a coin cell device with GP/MnO_2 as positive electrode and GP/Polypyrrole as negative electrode separated by an electrolyte (1M aqueous solution of Na_2SO_4) soaked separator.

References:

Zhang, L., Alvarez, M. Zhang, M, Haase. M, Malik. R, Mast D, Shanov, V., (2015), Preparation and characterization of graphene paper for electromagnetic interference shielding, Carbon, 82, 353-359.

Fabrication of carbon fiber-oriented Al-C composite and investigation of its thermal conductivity

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Abstract:

In recent years, heatsink materials having higher thermal conductivities have been required, due to the recent rapid improvements in CPU performance with increasing heat generation from computer devices. Here, composite material containing carbon fibers has been getting much attentions as an alternative material to conventional heatsink materials such as Al, because of its extremely high thermal conductivity. However, the extremely high thermal conductivity of carbon fiber is exhibited only in its longitudinal direction. Thus, it is significant to control the orientation of the carbon fibers in the composite material. In our preliminary study, it has been demonstrated that fibers can be oriented along the metal flow during hot extrusion processing of a fiber-powder mixture. In the present study, therefore, the hot extrusion is applied to fabrication of a carbon fiber oriented Al-C composite, and the effects of the volume fraction of the carbon fiber on the thermal conductivity of the composite have been investigated. The carbon fibers were mixed with pure Al powder with compositions ranging from 0 to 30 vol%. For the extrusion with 30 vol% of carbon fiber, 10 vol% of Al-12.2 mass%Si alloy powder was added to give better wettability to the Al/C interface. The thermal conductivities of the composite samples were measured with the laser flash method. It has been found that the carbon fibers are oriented successfully along the longitudinal direction of the extruded bar, and consequently, the thermal conductivity in the longitudinal direction of the bar increased with the increase in the volume fraction of the carbon fiber.

Keywords: Carbon fiber, Thermal conductivity, Composites, Extrusion, Orientation control.

Synthesis of low-temperature radio frequency plasma enhanced chemical vapour deposition transfer-free graphene

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Abstract:

Graphene is an attractive material for use in electronics, sensing, optoelectronic and many other applications due to its incredible properties. Syntheses of low-temperature graphene have been noteworthy studies among researchers in recent times (Kwak et al., 2012; Othman et al., 2015; Qi et al., 2012). Chemical vapour deposition (CVD) from hydrocarbon pre-cursors deposited on nickel (Ni) is so far the most promising technique for low-temperature graphene growth. Another important factor for low temperature synthesis is the deposition technique. Rf PECVD is probably the most effective method as rf PECVD could enhanced graphene growth rate at relatively lower temperature (Qi et al., 2012). However, those works required the graphene to be transferred to other potential substrate for application and the quality of the graphene is still low. Therefore, it remains a challenge to develop a technique for high quality transfer-free graphene at relatively low temperature. In this work, transfer-free graphene were grown using radio frequency plasma enhanced chemical vapour deposition technique at temperature as low as 380°C. The sequence of the growth process is illustrated in Figure 1. Variation of nickel thickness were sputtered and act as buffer layer to assist in control the formation of graphene. The role of Ni thickness were studied in terms of morphology and crystalline size. These finding represent an important step towards the fabrication of good quality transfer-free graphene films.

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Keywords: PECVD graphene, deposition, Nickel nanoparticles, Raman, XRD.

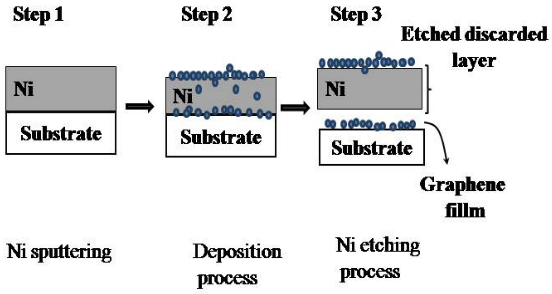

Figure 1: Schematic illustration of the formation process of graphene.

References:

Kwak, J., Chu, J. H., Choi, J.-K., Park, S.-D., Go, H., Kim, S. Y., . . . Yoon, E. (2012). Near room-temperature synthesis of transfer-free graphene films. *Nature communications, 3*, 645.

Othman, M., Ritikos, R., Muhammad Hafiz, S., Khanis, N. H., Abdul Rashid, N. M., & Abdul Rahman, S. (2015). Low-temperature plasma-enhanced chemical vapour deposition of transfer-free graphene thin films. *Materials Letters, 158*, 436-438. doi: http://dx.doi.org/10.1016/j.matlet.2015.06.039

Qi, J., Zhang, L., Cao, J., Zheng, W., Wang, X., & Feng, J. (2012). Synthesis of graphene on a Ni film by radio-frequency plasma-enhanced chemical vapor deposition. *Chinese Science Bulletin, 57*(23), 3040-3044.

Wafer-scale single-crystalline-like polycrystalline graphene with ZnO stitching

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Abstract: Large-area graphene films produced by means of chemical vapor deposition (CVD) are polycrystalline and thus contain numerous grain boundaries that can greatly degrade their performance and produce inhomogeneous properties. A better grain boundary engineering in CVD graphene is essential to realize the full potential of graphene in large-scale applications. Here, we report a defect-selective atomic layer deposition (ALD) for stitching grain boundaries of CVD graphene with ZnO so as to increase the connectivity between grains (Figure 1a-e). In the present ALD process, ZnO with hexagonal wurtzite structure was selectively grown mainly on the defect-rich grain boundaries to produce ZnO-stitched CVD graphene with well-connected grains (Figure 1f). For the CVD graphene film after ZnO stitching, the room-temperature mobility is improved to 5 times at a relatively low carrier density and the sheet resistance is decreased by 4 times, on a par with those of exfoliated, single-crystal graphene. We also demonstrate how ZnO-stitched CVD graphene can be successfully integrated into wafer-scale arrays of top-gated field effect transistors on 4-inch Si and polymer substrates.

Keywords: atomic layer deposition, zinc oxide, graphene, 2D nanosheet materials, field-effect transistors, grain boundaries, defects.

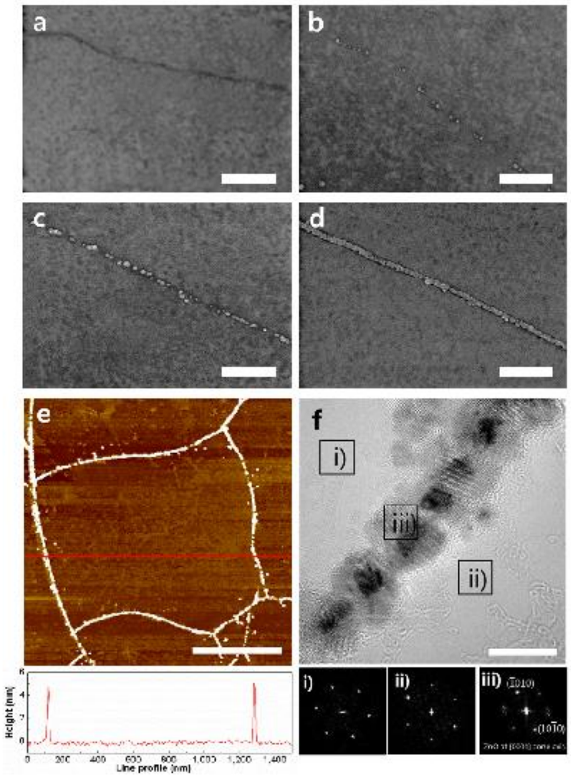

Figure 1: Images of the CVD graphene films with ZnO ALD. (a)-(d) SEM images of grain boundaries in CVD graphene be-fore and after ZnO ALD with 10, 20 and 30 cycles, respectively (scale bars, 200 nm). (e) (Top) AFM image of grain boundaries in CVD graphene after 30 ALD cycles of ZnO (scale bar, 500 nm). (Bottom) Height profile along the red line in the AFM image. (f) TEM image of a grain boundary in CVD graphene after 30 ALD cycles of ZnO (scale bars, 10 nm) and its corresponding FFT images from selected areas denoted by i) - iii), respectively..

References:

1. Yu, Q., Jauregui, L. A., We, W., Colby, R., Tian, J., Su, Z., Cao, H., Liu, Z., Pandey, D., Wei, D., Chun, T. F., Peng, P., Guisinger, N. P., Stach, E. A., Bao, J., Pei, S., Chen, Y. P. (2011) Control and characterization of individual grains and grain boundaries in graphene grown by chemical vapour deposition, *Nat. Mater.*, 10, 443-449
2. Tsen, A. W., Brown, L., Levendorf, M. P., Ghahari, F., Huang, P. Y., Havener, R. W., Ruiz-Vargas, C. S., Muller, D. A., Kim, P., Park, J. (2012) Tailoring electrical transport across grain boundaries in polycrystalline graphene, *Science*, 336, 1143-1146

A New Series of Porous Lanthanide-2,6-Pyridinedicarboxylate Frameworks: Synthesis, Structures and Photoluminescence Properties

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Abstract:
A new series of isostructural lanthanide-based metal organic frameworks, $[Ln_3(pdc)_3(H_2O)_{12}]\cdot 2Cl$ (Ln = Pr (**1**), Nd (**2**), Sm (**3**), Eu (**4**), Gd (**5**); H_2pdc = pyridine-2,6-dicarboxylic acid) have been synthesized using microwave technique. The structures and properties were characterized by single-crystal X-ray diffraction, elemental analysis, vibrational spectroscopy and thermogravimetric analysis. The compounds (**1**–**5**) display 3D frameworks with 1D channels extending in four different directions along the -3 axes; [1 1 1], [-1 1 1], [1 -1 1] and [1 1 -1]. Inside these channels, there located the chloride anions which are transfixed by hydrogen bonding interactions with ligated water molecules. The frameworks can be simplified to two interpenetrating 3D nets; the uninodal 4-connected 6^6-**lcs** net and the uninodal 6-connected $\{4^{12}\cdot 6^3\}$-**pcu** alpha-Po primitive cubic net. The photoluminescence properties of these compounds were investigated, among which intense red-emission is observed for compound **4**.

Keywords: lanthanide, pyridine-2,6-dicarboxylic acid, metal organic frameworks, porous, interprenetrating net, photoluminescence

Synthesis of Zinc Oxide Crystal Scaffolds with Strong Near Band Edge Emissions

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Abstract

We report the synthesis of hierarchically porous ZnO scaffolds that exhibit primarily, strong, Near Band Edge (NBE) emission ($\lambda_{excitation}$= 337 nm) at room temperature, without any (broad band) green luminescence. These scaffolds were deposited by a scalable supercritical CO_2 (sc-CO_2) based nebulization process, under mild processing conditions (P= 145 bar; T = 110° C). This process consists of an impinging jet of aerosol of CO_2 enriched zinc acetate solution micro-droplets (~ 3μm diameter) onto a heated silicon substrate at 135 ± 5°C, resulting in the formation of porous scaffolds consisting of 1-5 μm sized pores. Micro-porous Hydrozincite scaffolds are also produced along with ZnO (hexagonal wurtzite type zincite). Band edge absorption (362 nm) and band gap values (3.27 eV) further confirmed ZnO optical characteristics. Post deposition hot water treatment of these scaffolds resulted in re-crystallization of nano sized, flake-like and rod-like morphologies. This treatment doubled the NBE intensity but also resulted in the appearance of a weak, green photoluminescence (PL). Our experimental data indicated that NBE and green emissions might be due to the roles of shallow acceptors, crystal defects and sublevel transitions, respectively, in the ZnO crystals. With the strong blue emission properties, these films have potential applications in the development of optoelectronic devices such as light-emitting diodes (LEDs), low threshold UV/ sharp blue lasers and nano-lasing devices.

Keywords: Semiconductors, ZnO, X-ray diffraction, Blue emission, Optical properties, Photoluminescence.

Signal Amplification in Polymeric Materials Using Self-Propagating Responses and Continuous Head-To-Tail Depolymerization

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Abstract:

Signal amplification is an efficient method for detecting trace levels of an analyte. Herein, we present our progress on including signal amplification in polymeric materials using self-propagating reactions or controlled depolymerization (Figure 1). Signal amplification enables materials to detect specific signals sensitively while also providing rapid, macroscopic changes in the properties of the material. For the self-propagating response (Figure 1a), we designed stimuli-responsive polymers that contain chemical reporters appended on each repeating unit. Once a local, fleeting signal is applied, the reporters are released, ultimately inducing a global change over the entire material via a self-propagating reaction. With this domino-like reaction, a polymeric film changed from hydrophobic to hydrophilic (Kim et al., 2015, Chem. Sci.), while another film transformed from non-fluorescent to fluorescent (Mohapatra et al., 2015). Our second strategy uses self-immolative polymers (Phillips et al., 2014), specifically poly(benzyl ether)s that show continuous head-to-tail depolymerization through sequential quinone methide eliminations, once triggered by external stimuli (Figure 1b). Functionalization of this polymer provides recyclable materials and rapid solid-state depolymerization (Baker et al., 2015; Yeung et al., 2015). Alternatively, conjugating a polymerizable group on each repeating unit created a macro-cross-linker that provides a cross-linked adhesive that switches off its adhesive property de-cross-linking in response to a specific signal (Kim et al., 2015, Angew. Chem., Int. Ed.).

Keywords: stimuli-responsive materials, polymers, signal amplification, self-propagation, depolymerization, adhesive, recycling.

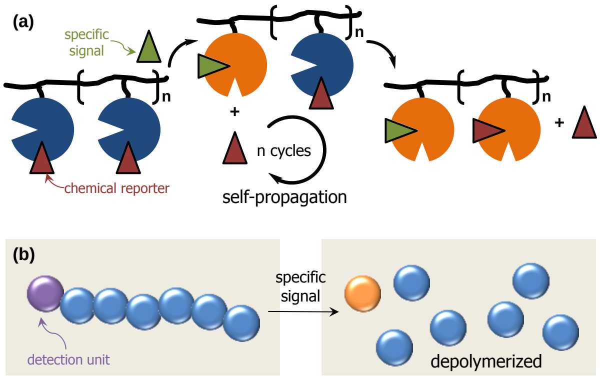

Figure 1: Signal amplification in polymeric materials using self-propagating reactions (a) or depolymerization (b). (a) A specific signal reacts with one repeating unit and liberates the appended signal that then induces self-propagation by generating more copies of signal. (b) Depolymerizable polymer that unravels all repeating units in the polymer backbone in response to a specific signal.

References:

Kim, H., Baker, M. S., Phillips, S. T. (2015) Polymeric materials that convert local fleeting signals into global macroscopic responses, *Chem. Sci.*, 6, 3388–3392.

Mohapatra, M., Kim, H., Phillips, S. T. (2015) Stimuli-responsive polymer film that autonomously translates a molecular detection event into a macroscopic change in its optical properties via a continuous, thiol-mediated self-propagating reaction, *J. Am. Chem. Soc.*, 137, 12498–12501.

Phillips, S. T., DiLauro, A. M. (2015) Continuous head-to-tail depolymerization: an emerging concept for imparting amplified responses to stimuli-responsive materials, *ACS Macro Lett.*, 3, 298–304.

Baker, M., Kim, H., Olah, M., Lewis, G., Phillips, S. T. (2015) Depolymerizable poly(benzyl ether)-based materials for selective room temperature recycling, *Green Chem.*, 17, 4541–4545.

Yeung, K., Kim, H., Mohapatra, H., Phillips, S. T. (2015) Surface-accessible detection units in self-Immolative polymers enable translation of selective molecular detection events into amplified responses in macroscopic, solid-state plastics, *J. Am. Chem. Soc.*, 137, 5324–5327.

Kim, H.; Mohapatra, H.; Phillips, S. T. (2015) Rapid, on-command debonding of stimuli-responsive cross-linked adhesives by continuous, sequential quinone methide elimination reactions, *Angew. Chem., Int. Ed.*, 54, 13255–13259.

Dielectric properties of novel lead-free Polyvinylidenefluoride-trifluoroethylene-$Bi_{0.5}Na_{0.5}TiO_3$ nanocomposite thin films

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Abstract:

Novel ferroelectric (0-3) nanocomposite films with bismuth sodium titanate, Bi0.5Na0.5TiO3 (BNT) particles as fillers and polyvinylidenefluoride-trifluoroethylene P(VDF-TrFE) copolymer as the matrix were prepared. Sol-gel method was used to synthesize the BNT nanopowder and spin coating was used to fabricate the nanocomposite films. The volume fraction of the BNT (∅) was in the range 0.1 - 0.3. The structural, dielectric, properties of the samples have been extensively investigated. Theoretical models, including Maxwell, Furukawa, Clausius-Mossotti, and effective medium theory (EMT) were employed to describe the effective dielectric permittivity of the composites. The permittivity for pure P(VDF-TrFE) and P(VDF-TrFE)-BNT composite thin films with various BNT volume fractions, which have been annealed at 100 ℃. The applied frequency ranged from 40 Hz to 1 MHz. The effective dielectric permittivity of the P(VDF-TrFE)-BNT composite increases as expected with the increase in the BNT volume fraction. The increase of □’ and □” for the P(VDF-TrFE)-BNT composite thin film with the increase in the BNT volume fraction in the low-frequency range is due to the increment of conductivity of the BNT ceramic. The contribution of the ceramic filler, BNT in the composite thin film will result in the rapid increase of □” at low frequency due to high conductivity of BNT. The interfacial polarization as a result of the heterogeneous structure (ceramic filler and polymer matrix) is produced by traveling charge carriers. The charges trapped at the interfaces cause large scale field distortions in contrast to other types of polarization (atomic and dipolar), which are produced by the displacement, or orientation of bound charge carriers. The 0-3 composite samples in this work can be modeled by a two phase dispersion system consisting of a polymer matrix (phase 1: P(VDF-TrFE)) and ceramic fillers (phase 2: BNT). The effective dielectric permittivity of a composite film is strongly influenced by the size, shape and volume fraction of the fillers. Thus, a few models have been used to understand the effective dielectric response of the composite films. It is found that EMT and Clausius-Mossotti have very good agreement with experimental result.

Keywords: Bismuth sodium titanate, $Bi_{0.5}Na_{0.5}TiO_3$ (BNT), Polyvinylidenefluoride-trifluoroethylene P(VDF-TrFE) copolymer, dielectric relaxation, The effective dielectric permittivity, Composite thin film.

Effect of Sc and Heat treatment on the microstructure and mechanical properties of A356 Aluminium alloy

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The effects of heat treated A356 aluminium alloy with Scandium addition (0.0wt%, 0.2wt%, 0.4wt% and 0.6wt%) have been investigated in present work.The specimens were prepared by gravity die casting process and machined according to ASTM B557-06 standard. The effect of heat treated A356 on microstructure,microhardness and tensile strength were examined by Scanning Electron Microscopy (SEM), Vicker's Hardness Tester and Instron Static Machine respectively. It was found that the silicon eutectic structure of A356 aluminium alloy had changed from coarse and elongated shape to finer and equiaxed structure and the average grain size was reduced by the addition of scandium. The addition of scandium from 0.00wt% to 0.4wt% does show the decreasing in average grain size. While increasing the scandium from 0.4wt% to 0.6wt% does not continue to show significant reduction in grain size and the grain size difference is only about 0.1 µm. It has been stated that the Al_3Sc phase forms as a product of a eutectic reaction during the solidification of Sc-containing Al melts and determine the eutectic phase morphology. T6 heat treatment plays an important role in the fragmentation and spheroidization of eutectic silicon, especially in the well modified alloy. The tensile properties were improved by the addition of scandium followed by the T6 heat treatment. A great combination of ultimate tensile strength (161.57MPa) and microhardness (118.10 HV) was obtained when the Sc addition was at 0.6wt% and heat treated.

Keywords: Aluminium alloy, A356, scandium, mechanical properties, microstructure, SEM, grain size.

Dry ice blasting as a substitution for conventional electroplating pre-treatment processes

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Abstract:
For high quality electroplated products, surfaces must be thoroughly pre-treated. For this purpose electroplating currently needs a variety of chemical baths. The used chemicals are injurious to health and harmful to the environment. In addition, the conventional pre-treatment has a long process time which results in high costs. Dry ice blasting alone or in combination with other processes has the potential to completely substitute these conventional pre-treatment processes.

Three process sequences as pre-treatment methods prior to electroplating were investigated on the aluminium alloys AlSi12 and AlMg3. The used processes are dry ice blasting, tempering during dry ice blasting and glass-bead blasting followed by dry ice blasting. The influenc of the parameters on the surface roughness, surface topography and surface tension of the workpieces was examined. A model to describe the correlation between the dry ice blasting parameters and surface parameters was developed. Finally, an adhesion test of electroplated test specimen was conducted in order to determine the suitability of these alternative pre-treatment processes.

Keywords: Coating; Electroplating; Surface analysis; Dry ice blasting

Acknowledgements:
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Effect of processing parameters on the morphology and wetting of electrospun mats

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Abstract:
Nano and microfibers produced by electrospinning form a nonwoven mat that can be used as a membrane for filtration, scaffold for tissue engineering, etc. Due to the large surface area and pore interconnectivity, controlling the surface properties of these mats is crucial to determine the performance. In many of the possible applications, for example, the membrane must respond to the interactions with an aqueous fluid. Hydrophobic mats can be used as a self-cleaning surface, while hydrophilic mats are usually preferred for biomedical and environmental applications. The latter is the focus of this work, in which polymer blending with amphiphilic PEO-PPO-PEO molecules was used as a one-step process for the hydrophilization of hydrophobic mats. The idea was to understand the influence of the processing parameters on the PEO-PPO-PEO segregation to the fibers surface. The PPO block, with smaller surface energy will tend to segregate to the surface and drag the PEO block. Once in contact with an aqueous medium, the PEO chain-ends will extend and hydrophilize the surface. Voltage, distance to collector and flow rate was varied to alter the mat porosity, while the relative humidity will affect fiber porosity. The influence of surface morphology and chemical composition on the wetting behavior of the mats was analysed (Figure 1). Different imaging techniques were used to characterize the morphology of the mats and individual fibers surface, while X-ray photoelectron spectroscopy was used to access the chemical composition at the very top.

Keywords: electrospinning, polymer processing, wetting, membranes, polymer blend.

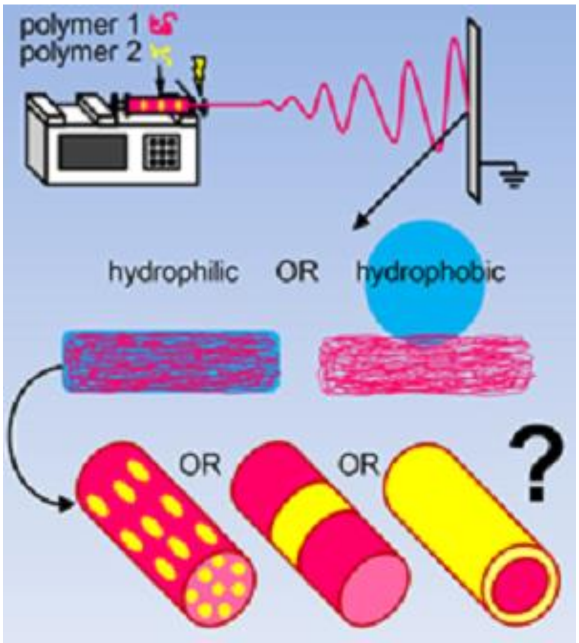

Figure 1: General idea behind this work

Low-temperature plasma modification of fillers for advanced polymer composites

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Abstract:

In polymer industry there still is a room for new fillers, which can improve composites performance or introduce a new function to the material. Modern fillers like carbon nanotubes or graphene nanoplatelets, are more and more often applied in advanced polymer composites technology. Very often it is hard to obtain a well dispersed system for such fillers – it's particles are not wet properly by the polymer during mixing. As a consequence, the total effect of mechanical properties improvement of a composite is lower than expected.

In this work multi-walled carbon nanotubes (MWCNT), graphene nanoplatelets (GnP) and carbon fibers surface was modified with low-temperature plasma. Attempts were made to graft some functional groups on plasma-activated material to make filler's surface chemically active during processing. The analysis of surface free energy of virgin and modified fillers was carried out. Ultimately rubber composites were produced, and their mechanical properties were studied.

Keywords: plasma, fillers, surface modification, carbon nanotubes, graphene nanoplatellets, polymer composites, elastomer composites

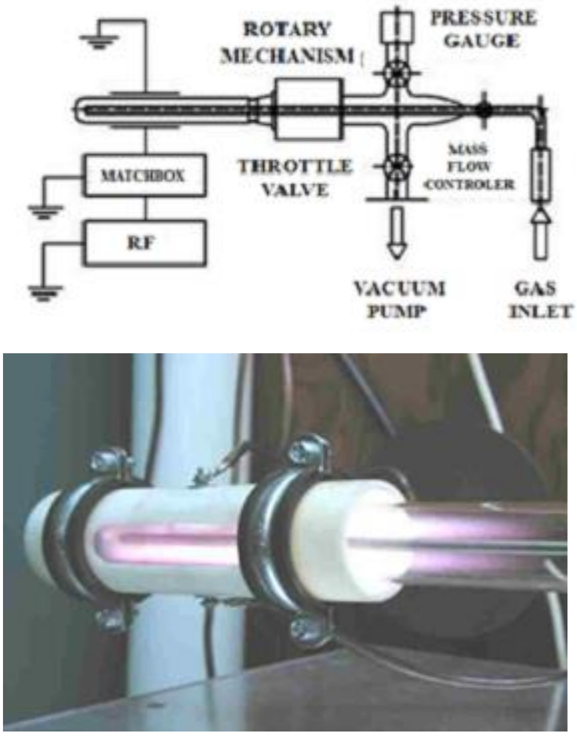

Figure 1: Schematic representation of a rotating plasma reactor and a reactor at work. **References:**

Acknowledgment The work has been supported by the Polish National Science Centre within the frame of the grant No DEC-2012/05/B/ST8/02922.

References:

Bieliński D. M., Dobrowolski O., Przybytniak G., *J. Appl. Polym. Sci.* **110**, 55 (2008).
Mittal V. Surface Modification of Nanotube Fillers, Viley-VCH Verlag GmbH, Veinheim, Germany, 2011.

The Square-Wave Galvanostatic Pulsed Co-electrodeposition of Ni-Zn Alloy on Steel Substrate: Effect of Duty Cycles

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Abstract:
In this study, the effect of various duty cycles (33%, 50% and 66%) under square-wave galvanostatic pulsed is used to electrodeposit the nickel-zinc (Ni-Zn) alloy from sulfate bath. The XRD results showed that the dominant phases of Ni-Zn electrodeposit are the mixtures of Ni_5Zn_{21}, Ni_3Zn_{22} and NiZn phases. In addition, the Ni content of the Ni-Zn electrodeposits using EDX varied from 9.40 to 12.58 wt%. According to the SEM images, the best of surface morphology of electrodeposit was the sample obtained by duty cycle 33%. The EIS and Tafel extrapolation were also used to study the performance of the Ni-Zn electrodeposits with respect to corrosion resistance.

Keywords: Electrodeposition, Zn-Ni Alloy, Pulse Current, Duty Cycle, Corrosion resistance

References:

1. Ghaziof, Soroor, and Wei Gao. "The effect of pulse elec-troplating on Zn–Ni alloy and Zn–Ni–Al2O3 composite coatings." *Journal of Alloys and Compounds* 622 (2015): 918-924.
2. Ghaziof, Soroor, and Wei Gao. "Zn–Ni–Al2O3 nano-composite coatings prepared by sol-enhanced electroplating." *Applied Surface Science* 351 (2015): 869-879.
3. Ghaziof, Soroor, Paul A. Kilmartin, and Wei Gao. "Electrochemical studies of sol-enhanced Zn–Ni– Al2O3composite and Zn–Ni alloy coatings." *Journal of Electroanalytical Chemistry* 755 (2015): 63-70.
4. Pagotto, Oswaldo.S., Marina.C., Freire.D.A., and Ballester.M.. "Zn–Ni alloy deposits obtained by continuous and pulsed electrodeposition processes." *Surface and Coatings Technology* 122.1 (1999): 10-13.
5. Tozar.A., and Karahan.I.H.. "Structural and corro-sion protection properties of electrochemically de-posited nano-sized Zn–Ni alloy coatings." *Applied Surface Science* 318 (2014): 15-23.

Smart Materials Analysis as a Medium of Protection in Aircraft Fuselage

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Abstract:
When travel makes one modest, people prefer air travel instead of land travel. Under this circumstance, during flight, aircrews and flight passengers are prone to electromagnetic (EM) radiation exposure overtime. Indeed, both aircrews and passengers are having higher risk, and it is unavoidable to induce very close relationship between layers of atmosphere with the EM radiation. In line with this, passing through layers of atmosphere leads to more risk of EM radiation exposure compared to human beings who live on Earth's surface. Various researches conducted; show that EM radiation has a major effect to human body. Human body tolerance to electromagnetic field is about 30-300 MHz in frequencies. When the frequency exceeds the limit, it may generate increasing of internal heat of human body and hence it triggers the mechanisms of heat regulation in the human body, especially in blood system. Since blood is moving holistically inside the body, it may cause a fatal hazardous on human's vital organ. NASA has claimed that hydrogen is a very effective material to absorb photon and energetic particles occur due to the photon energy interaction with matter. However, the impossibility to produce a structure form fully water, the material which has hydrogen rich became an alternative to be developed on. Besides, low Z materials or low atomic number of materials also may be used as alternative due to its capability to absorb radiation and tend to avoid a decay reaction that will give rise of scattered energetic particles. This paper offers reviews of EM radiation effect to human body in altitude of commercial jet and sort of materials that may provide a convince protection for fuselage structure of aircraft.

Keywords: Electromagnetic radiation, shielding materials, aircraft, polyethylene, boron nitride, epoxy.

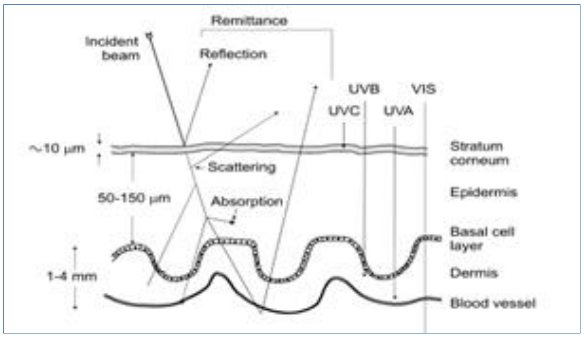

Figure 1: The UV Radiation Exposure to Human Tissue

References:

1. M. G. Tosato, and et.al (2015), Confocal Raman spectroscopy: In vivo biochemical changes in the human skin by topical formulations under UV radiation, *J. Photochemistry and Photobiology.*,153, 51-58.
2. H. Wang, L. Xu, J. Hu, M. Wang, G. Wu (2015), Radiation-induced oxidation of ultra-high molecular weight polyethylene (UHMWPE) powder by gamma rays and electron beams: A clear dependence of dose rate, *Radiation Physics and Chemistry*, 115, 88-96.

Highly Stable Water-Soluble Platinum Nanoparticles Stabilized by Hydrophilic N-Heterocyclic Carbenes

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Abstract:

The synthesis of metal nanoparticles under controlled conditions in water remains a challenge in nanochemistry. Three different approaches are disclosed here for platinum, which involve the thermal decomposition under controlled conditions and the treatment with CO of aqueous solutions of preformed sulfonated (NHC)Pt(II) complexes (NHC = N-heterocyclic carbene), as well as the treatment (NHC)Pt(0) complexes with H_2. (Figure 1).

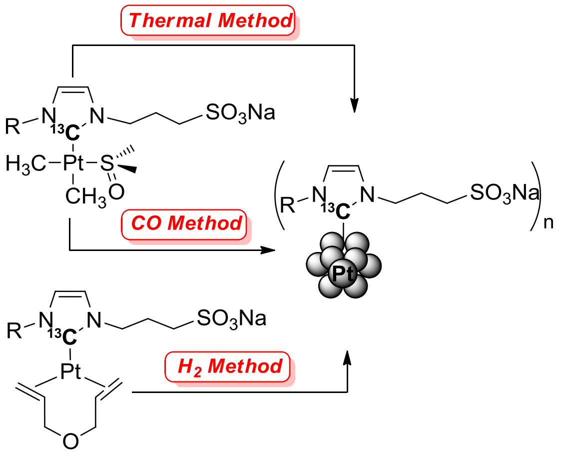

Figure 1: Synthesis of water-soluble platinum nanoparticles here presented.

The resulting nanoparticles were found to be water-soluble, and highly stable in this solvent under air for indefinite time period. The particles were characterized by TEM and spectroscopic techniques. The coordination of NHC ligands through the carbenic carbon was corroborated by solid-state NMR studies, where an unambiguous evidence of such a bonding was obtained by the determination of the $^{13}C–^{195}Pt$ coupling constant (940 Hz) for particles containing a ^{13}C labeled-NHC ligand. The coordination of CO to (NHC)Pt(II) precursors, prior to the formation of the nanoparticles, studied by NMR spectroscopy will be presented. A second coordination sphere containing bis(NHC)Pt(II) complexes found for a particular type of NHC ligand, will be also discussed.

Although the comparison of the procedure using CO with that one through thermal decomposition of dimethyl precursors, showed only significant differences in the reaction time (faster for the latter), the synthesis of PtNPs by using the hydrogenation method was found to progress even much slower than the decomposition under CO and produced bigger NPs. In addition, the study highlighted the importance of ligand design for the NPs stabilization. (Baquero *et al.*; 2014, 2015).

Keywords: N-heterocyclic carbenes, nanoparticles, platinum, solis-state NMR spectroscopy, surface charcterization.

References:

Baquero, E. A., Tricard, S., Flores, J. C., de Jesús, E., Chaudret, B. (2014), Highly stable water-soluble platinum nanoparticles stabilized by hydrophilic N-Heterocyclic Carbenes, *Angew. Chem. Int. Ed.*, 53, 13220-13224.

Baquero, E. A., Tricard, S., Coppel, Y., Flores, J. C., de Jesús, E., Chaudret, B. (2015), Water-soluble platinum nanoparticles stabilized by sulfonated N-Heterocyclic Carbenes: Effect of the synthetic approach, *In Preparation*.

New Colored Zinc Borophosphate Glasses

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Abstract:

Generally, phosphate glasses are hygroscopic and water dissolution affecting to a restriction on utilization of phosphate glasses in a wide range of applications. In this research, the new colored zinc borophosphate glasses with the improvement of chemical properties, physical properties and optical properties of phosphate glasses were synthesized by conventional melt quenching method. The glasses were colored by metal oxides dopants e.g. CuO, TiO2, Mn2O3 and Cr2O3. These colored zinc borophosphate glasses were characterized by X-ray diffraction (XRD) for crystal structure study, Scanning electron microscopy (SEM) for surface morphology observation, UV-Visible spectroscopy for light absorption and Raman spectroscopy for determination of glass structure. The results demonstrated that these glasses have a higher tolerance of water dissolution when increases of ZnO concentration. Enhancement of thermal expansion coefficient was obtained with increase of B2O3 concentration. Metal oxide dopants create a wide variety of colored zinc borophosphate glasses e.g. yellow, dark green, purple and blue. Moreover, the colored zinc borophosphate glasses enhanced the water dissolution simontaneously, which can be confirmed by the stretching vibration of Raman spectroscopy. This study will contribute to a development of colored zinc borophosphate glasses in several optical applications.

Keywords: borophosphate glasses, colored glasses, amorphous materials, zinc oxide.

Figure: The synthesized colored zinc borophosphate glasses e.g. colorless, yellow, dark green, purple and blue

References:

1. Takebe, H., Baba, Y., Kuwabara, M. (2006), Dissolution behavior of ZnO–P2O5 glasses in water, *Journal of Non-Crystalline Solids*, 352, 3088–3094.
2. Koudelka, L., Mosner P. (2000), Borophosphate glasses of the ZnO–B2O3–P2O5 system, *Materials Letters*, 42, 194–199.
3. Yazawa, T., Machida, F., Oki, K., Mineshige, A., Kobune, M. (2009), Novel porous TiO2 glass-ceramics with highly photocatalytic ability, *Ceramics International*, 35, 1693–1697.

Tailored chemically patterned surfaces for the control of the frictional behavior at polymer-polymer interfaces

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Abstract:

There are many common situations where contact interfaces involving elastomers are used for adhesion and/or friction functions: for example, tire/road contact in the automotive or plunger/syringe contact in the medical industries. For decades, a growing interest has been developed in controlling friction through surface modification [1], with the main effort being on topographical features [2]. In our work we are developing a general methodology (Figure 1A) to design well-defined surfaces combining microcontact printing (µCP), self-assembled monolayers (SAMs) and polymer grafting techniques not only to control the geometrical and mechanical properties of surface, but also to precisely tune the surface energy using a broad range of functionalities (Figures 1A-B). The frictional behavior on patterned surfaces was investigated:

a- at micro and nano scales by following the dewetting of an ultrathin polymer film (sliding of a polystyrene thin film onto the modified substrate). Figure 1(C) shows an example of the dewetting of a polystyrene thin film on homogenous and hetero-chemically patterned surfaces.

b- at macro scales by following the evolution of the frictional coefficient at the contact between a rubber sphere and textured substrates.

Consequently, we show that the printed hetero-chemical patterns play a key role in the rupture properties of contact interfaces.

Keywords: Ultrathin polymer film, wetting and dewetting, microcontact printing, atomic force microscopie, frictional behavior, micropatterning, contact interfaces, tribology.

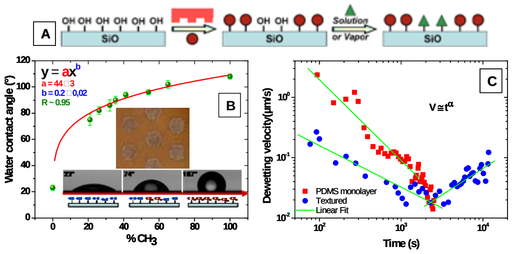

Figure 1: *(A) Schematic representation for designing tailored chemical patterned surfaces combining µCP and SAMs processes.* ● *and* ▲ *are functionalized triethoxy- or trichloro-silane. (B) The evolution of water contact angle with the percentage of grafted methyl groups. (C) The dewetting velocity on homogenous and hetero-chemically patterned surfaces.*

References:

K. Holmberg, H. Ronkainen, A. Laukkanen, K. Wallin, *Surf. Coat. Tech.* 202, 1034 (2007).

A. Jagota, C.-Y. Hui, *Mat. Sci. Eng. R* 72, 253 (2011).

Carbon nanowalls prepared by home-built plasma assisted hot wire chemical vapor deposition

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Abstract:

Synthesis of carbon nanomaterials including carbon nanotubes, carbon nanotips, carbon nanowalls and graphene have attracted numerous attention due to its outstanding mechanical, electronic and optical properties (Liu et. al.). Among them, carbon nanowalls which are composed of layer of stacking graphene sheets standing vertically on substrate have characteristics such as high aspect ratio, large surface area and mechanical strength for application in photocatalysis, solar cell, sensor and field emission electron sources (Wang et. al., Mori et. al.) Various deposition procedures have been explored to fabricate carbon nanowalls such as hot wire chemical vapor deposition, radical injection plasma enhanced chemical vapor deposition and microwave plasma enhanced chemical vapor deposition (Cho et. al., Wang et. al.). In this study, carbon nanowalls were fabricated by a home-built plasma assisted hot wire chemical vapor deposition. Methane and hydrogen were used as precursor in samples preparation. The samples were deposited on SiO_2 substrate. The effect of deposition time of carbon nanowalls was studied. Morphology of the sample was characterized by field emission scanning electron microscopy. The results showed high density vertically aligned carbon nanowalls uniformly grown as illustrated in Figure 1. Structural properties studied from Raman spectroscopy indicated that the carbon nanowalls contained highly ordered structures with graphene domains.

Keywords: carbon nanowalls, plasma, hot wire chemical vapor depositon

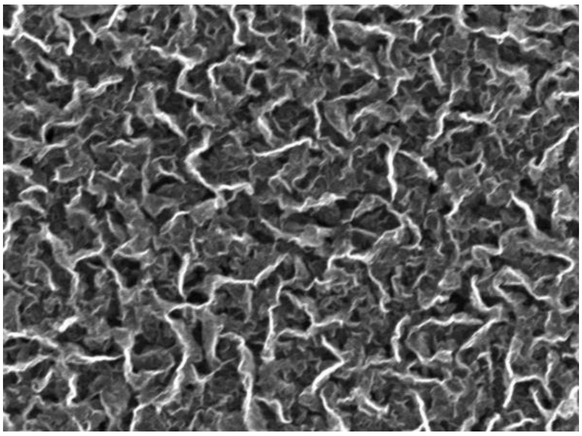

Figure 1: FESEM image of carbon nanowalls prepared by a home-bulit plasma assisted hot wire chemical vapour deposition.

References:

Cho, H. J., Kondo, H., Ishikawa, K., Sekine, M., Hiramatsu, M., Hori, M., Density control of carbon nanowalls grown by CH4/ H2 and their electrical properties, Carbon 68 (2014) 380-388.

Liu, H., Zhang, Y., Li, R., Cai, M., Sun, X., Synthesis and characterization of TiO2@C core-shell nanowires and nanowalls via chemical vapor deposition for potential large scale production, J. Colloid Interface Sci. 367 (2012) 115-119.

Mori, S., Ueno, T., Suzuki, M., Synthesis of carbon nanowalls by plasma-enhanced chemical vapor deposition in a CO/H_2 microwave discharge system Diamond & Relat. Mater. 20 (2011) 1129-1132.

Wang, Y., Li, J., Song, K., Study on formation and photoluminescence of carbon nanowalls grown on silicon substrate by hot filament chemical vapor deposition, J. Lumin 149 (2014) 258-263.

Wang, H., Quan, X., Yu, H., Chen, S., Fabrication of a TiO_2/carbon nnanowall heterojunction and its photocatalytic ability, Carbon 46 (2008) 1126-1132.

The Wear Behavior of Al7075-T651 Coated with Micro Arc Oxidation Method

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Abstract:
The principle of coating with MAO method is mainly based on the coating of the substrate material with an abrasion and corrosion resistant, hard layer by immersing into the electrolytic liquid by means of the plasma discharges obtained by the influence of electrochemical reactions [1]. In the MAO method, the composition of the oxide layer can be modified by adding different chemicals into the electrolyte solution [2]. In this study, Al7075-T651 substrate material was coated by the micro arc oxidation (MAO) method in two different solutions and the effects of changing experimental parameters and Ti addition on the abrasion resistance were investigated. The first solution includes potassium hydroxide, sodium aluminate and sodium phosphate. The second solution differs from the first one only with the addition of the nano titanium particles. With these solutions, two different coatings were performed. After the coating process with the certain frequencies, the voltages and the coating times, the wear tests of coated samples were effectuated on the block-on-disc abrasion test unit. The weights of the samples were recorded after every 500, 1000 and 1500 m wear distances with 10^{-5} g sensitive scales. Additionally SEM, EDX and XRD analysis of the coated materials with and without the titanium added solution were carried out seperately. As a result, it was observed that, the amount of wear decreased with the increasing voltage, frequency and processing time, and the wear was found to be less in the Ti-added coatings. However, the coating thickness increased with the increasing voltage, frequency and processing time. According to the analysis of XRD, it was confirmed that Al_2O_3 phase occurred on the samples coated without Ti solution. And it was observed that TiO phase were found in the microstructure of the samples coated with Ti-added solution.

Keywords: mao, micro-arc oxidation, coating, aluminium, titanium, wear, AA7075.

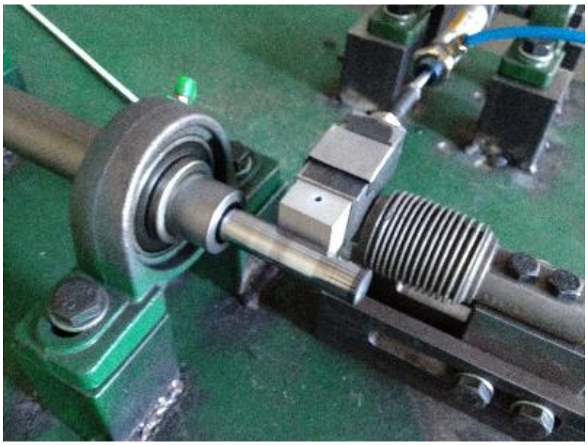

Figure 1: Figure illustrating the wearing of the samples coated with micro-arc oxidation method by using different parameters. The wear tests of coated samples were effectuated on the block-on-disc abrasion test unit.

References:

1. Huang P., Zhang Y., Xu K., Han Y., Huang P., Zhang Y., Xu K., Han Y., “Surface Modification of Titanium Implant by Micro Arc Oxidation and Hydrothermal Treatment, Journal of Biomedical Materials Research”, Chapter: B Applied Biomaterials, Volume: 70B, N:2, 187-190, (2004).
2. Li H., Song R., Ji Z., “Effects of Nano-Additive TiO2 on Performance of Micro-Arc Oxidation Coatings Formed on 6063 Aluminum Alloy”, Transactions of Nonferrous Metals Society of China, Volume 23, Issue 2, Pages 406–411, (2012).

Fabrication of self-healing porous concrete to eliminate failure caused by alkaline-silica reaction (ASR)

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Abstract:
Alkaline-silica reaction (ASR) is one of the crucial factors contributing to internal failure of concrete. ASR generally involves formation of swelling calcium solicate hydrate gel that exerts an expansive pressure, leading to serious cracking in concrete. This research, hence, aims at inventing smart concrete that is susceptible to cracks originated from ASR. In this study, self-healing porous concrete was successfully fabricated. Aluminum powder, acting as an air entrainment agent, with the concentrations ranging from 0.05, 0.1, 0.15, 0.2 wt% was added to mixture of borosilicate glass, sand, aggregates, and cement prior to casting. Physical and microstructural investigation of the cast concrete revealed that a larger quantity of aluminum addition resulted in a higher porosity. Formation of the pores accommodated calcium solicate hydrate gel and reduced the expansive pressure, which consequently led to elimination of cracks.

Keywords: Alkaline-silica reaction, porous concrete, Aluminum powder, air entrainment agent

Subsolidus phase equilibria and electrical properties of pyrochlores in the Bi_2O_3-CuO-Ta_2O_5 ternary system

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Abstract:

The pyrochlore structure is often represented by a general formula of $A_2B_2O_7$ or $A_2O'•B_2O_6$. A broad range of chemical substitutions at the A, B and O crystallographic sites could produce hundreds of compositions with a specific set of desired properties for the electrical, magnetic and optical applications. The A element could be a rare earth cation with inert lone pair electrons and B element could be a transition metal with inert lone pair electrons and B element could be a transition metal with variable oxidation states and/or a post transition metal. Ternary systems in the complex family of bismuth-based pyrochlores, e.g. Bi_2O_3-ZnO-Nb_2O_5 (BZN) and Bi_2O_3-ZnO-Ta_2O_5 (BZT) have captured much research impetus due to their excellent composition-dependent dielectric properties.[1-3]

In this study, subsolidus phase relations have been determined for the Bi_2O_3-CuO-Ta_2O_5 (BCT) system over the temperature range 700-950°C in air (Fig. 1). Two structurally distinct ternary phases of different symmetries, cubic pyrochlore and monoclinic zirconolite were observed. Phase-pure pyrochlores existed in a unique boomerang-shaped area, which could be described using the general formula, $Bi_{2.48+y}Cu_{1.92-x}Ta_{3.6+x-y}O_{14.64+3x/2-y}$: $0.00(1) \leq x \leq 0.80(1)$ and $0.00\ (1) \leq y \leq 0.60(1)$, respectively. BCT pyrochlores exhibited total electrical conductivities, 10^{-7}-10^{-6} S cm^{-1}, dielectric constants, ε', ~ 60-80 and dielectric losses, tan δ, ~ 0.01-0.20 at 1 MHz and ambient temperature, ~ 28°C. Low activation energies, 0.32-0.40 eV suggesting that BCT pyrochlores are of semiconductor-type and their electrical conduction mechanisms are governed by both grain and grain boundary.

Keywords: Pyrochlore, Phase diagram, electrical conductivity and dielectric constant

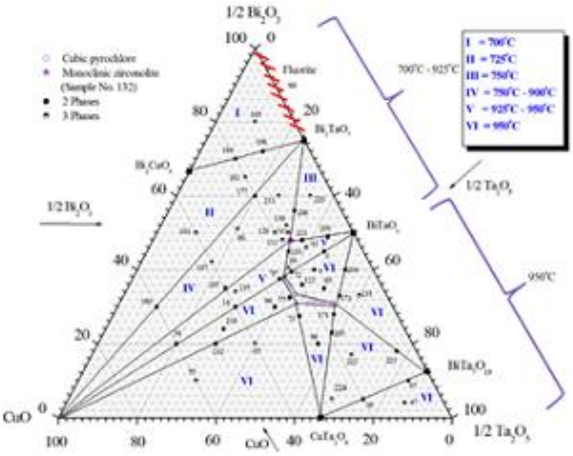

Figure. 1 illustrating the layout of the compatibility triangles covering various two-phase, three-phase and a single phase solid solution area in the BCT phase diagram. Different phase assemblages in the isothermal regions (I-IV) are determined as to control the weight loss problem of the Cu- and Bi-rich compositions

References:

1. Subramanian MA, Aravamudan G, Subba Rao GV. *Prog. Solid State Chem.* 1983; 15:55.
2. Tan KB, Lee CK, Zainal Z, Miles GC, West AR. *J. Mater. Chem.* 2005; 15:3501.
3. Khaw CC, Tan KB, Lee CK, West AR. *J. Eur. Ceram. Soc.* 2012; 32:671

Session II:
Smart Materials for Energy Harvesting and storage / Environment / Electronics

Smart functional materials for energy harvesting: from laboratory to commercialisation

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Abstract:

The piezoelectric effect in Poly(vinylidene fluoride), PVDF, was discovered over 40 years ago and since then, significant work has been carried out aiming at the production of high β-phase fibres and their integration into fabric structures for energy harvesting. However, little work has been done in the area of production of "true piezoelectric fabric structures" based on flexible polymeric materials such as PVDF. In this work, we demonstrate "3D spacer" technology based all-fibre piezoelectric fabrics as power generators and energy harvesters (Figure 1(a)). The knitted single-structure piezoelectric generator consists of high β-phase (~80%) piezoelectric PVDF monofilaments as the spacer yarn interconnected between silver (Ag) coated polyamide 66 multifilament yarn layers acting as the top and bottom electrodes. The novel and unique textile structure provides an output power density in the range of 1.10 - 5.10 μWcm^{-2} at applied impact pressures in the range of 0.02 - 0.10 MPa, providing significantly higher power outputs and efficiencies over the existing 2D woven and nonwoven piezoelectric structures (Figure 1(b)). This all fibre piezoelectric fabric possesses the advantage of efficient charge collection due to intimate contact of electrodes and uniform distribution of pressure on the fabric surface, leading to enhanced performance. Moreover, the "feel" of the all-fibre piezoelectric generator is not very different from any other conventional textile material and is soft and flexible providing potential maximum level of comfort to the wearer. Bearing all these merits in mind, we believe our method of producing large quantities of high quality piezoelectric yarn and piezoelectric fabric provides an effective option for the development of high performance energy-harvesting textile structures for electronic devices that could be charged from ambient environment or by human movement. Furthermore, via the creation of hybrid photovoltaic films and fibres, energy can be captured from solar radiation and used where the mechanical impetus is absent. The high energy efficiency, mechanical durability and comfort of the soft, flexible and all-fibre based power generator is highly attractive for a variety of potential applications such as wearable electronic systems and energy harvesters charged from ambient environment or by human movement.

Keywords: Poly(vinylidene fluoride) PVDF, energy harvesting, piezoelectric effect, 3D spacer, textiles,

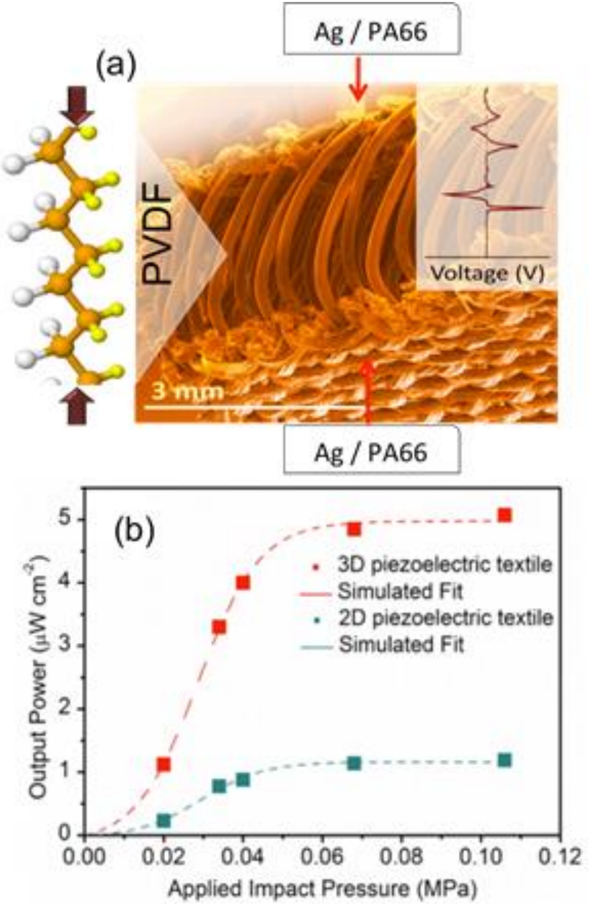

Figure 1: Figure illustrating (a) the structure of 3D spacer piezoelectric fabric, (b) measured power output of the 2D and 3D piezoelectric fabrics as a function of the impact pressure.

References:

1. Soin, N., Shah, T. H., Anand, S. C., Geng, J., Siores, E. et al (2014) Novel 3D-spacer all fibre piezoelectric textiles for energy harvesting applications, *Energy Environ. Sci*, 7(5), 1670-1679
2. Soin, N., Shah, T. H., Anand, S. C., Siores, E., (2013) 3D spacer piezoelectric fabrics and production of thereof, *UK Patent application no. 1313911.8*
3. Siores, E., Hadimani, R. L., Vatansever (2012) Piezoelectric polymer element and production method and apparatus thereof, *WO Patent WO/2012/035350*

Tunability and piezoelectric properties of $Ba_{1-x}Ca_xTi_{1-y}Zr_yO_3$ based thin film capacitors

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Abstract :

Tunable ferroelectric capacitors, which exhibit a decrease of the dielectric permittivity (ε) under electric field, are widely used in electronics for RF tunable applications (e.g. antenna impedance matching). Current devices use barium strontium titanate (BST) as the tunable dielectric and the need for performance improvement of the tunable element is the key for device improvement. For this purpose, we chose to investigate the $BaTiO_3$-$CaTiO_3$-$BaZrO_3$ ternary phase diagram. Indeed, it has been recently shown, for $(1-x)BaTi_{0.8}Zr_{0.2}O_3$-$xBa_{0.7}Ca_{0.3}TiO_3$ (BCTZ) ceramics[1], an increase in dielectric, piezoelectric and ferroelectric properties due to the presence of a morphotopic phase boundary (MPB) for x=0.5 that could lead to an increased tunability. More recently, thin films of BCTZ on $Pt/TiO_2/SiO_2/Si$ substrates, with composition at the MPB, were deposited via pulsed laser deposition (PLD), and shown a tuning ratio (defined as the ratio of the maximum of permittivity by the permittivity under an electric field) of about 5/1 under a field of around 300kV/cm[2].

We report here on libraries of BCTZ thin films deposited on $IrO_2/SiO_2/Si$ substrates using combinatorial pulsed laser deposition (CPLD) allowing for gradients of composition on one sample[3]. The dielectric properties were investigated for about 600 capacitors (about 40 different compositions and 12 per composition) for one sample for statistics. Effective piezoelectric coefficient d_{33} were also measured across the ternary phase diagram. We show that high tunability (>60%) can be obtained under an electric field of 250kV/cm, that the role of zirconium and calcium for dielectric loss reduction and tunability are intricated and not monotonic but also that the lowest dielectric losses and maximum tunabilities are not necessarily correlated. Finally, we show that CPLD is a powerful tool to perform fine and continuous scans of the $BaTiO_3$-$CaTiO_3$-$BaZrO_3$ ternary phase diagram in order to identify the best compromise depending on the needs (low V, high tunability, low dielectric losses, figure of merit, high d_{33}...).

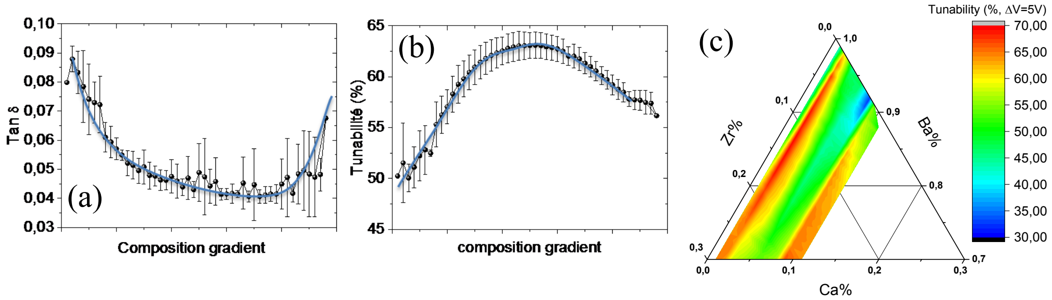

Fig. 1: Tan δ (a) and tunability (b) as a function a composition for a BCTZ library. (c) Contour maps showing the tunability as a function of compositions.

References

[1] W. Liu et X. and Ren, *Phys. Rev. Let.* **103**, 257602 (2009).
[2] A. Piorra, P. A., H. Kohlstedt, M. Wuttig and E. Quandt, *J. Appl. Phys.* **109**, 104101 (2011).
[3] G. Liu *et al.*, J. Appl. Phys. **108**, 114108 (2010).

Ultra-high mobility graphene through support-layer engineering

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Abstract:

Graphene's successful role in high-speed electronics, novel sensors, and exotic device concepts relies on breakthroughs in achieving consistently high carrier mobilities at large scales.(Novoselov *et al.*, 2012) Two main factors have been identified that deteriorate the performance of graphene. Polymers, that are required during the transfer step of CVD graphene from the catalyst to a target substrate, leave behind residue that acts as charged impurities and hinders carrier transport. Furthermore, the commonly used SiO_2 substrate induces spatially varying charge puddles that contribute to lower carrier mobilities.(Zhang *et al.*, 2009)

Our work is exploring polyolefinic polymers to address both sources of carrier scattering. We found that graphene exhibits a fivefold enhanced carrier mobility when supported on polyolefins compared to graphene on PMMA or SiO_2. Centimeter-scale films exhibited carrier mobilities in excess of 10,000cm^2/Vs which is a surprisingly high value in the presence of boundary scattering. Hall-effect measurements reveal that this unprecedentedly high mobility originates from a suppression of charged impurities compared to traditional support materials.

These results furthermore allow us to elucidate the factor controlling carrier mobility in traditional graphene devices. Transfer using polyolefins and PMMA reveal a significantly lower amount of C-O bonds in polyolefin-transferred graphene. Correlation with transport measurements and Raman spectroscopy shows that oxygen-containing polymer residue is the source of charged scatterers that deteriorate graphene's mobility.

Based on these findings, the absence of oxygen-containing groups was established to be an important property of graphene-supporting polymers. A wide variety of polyolefins with different purity and structure was tested to confirm this hypothesis and consistently high graphene performance after transfer was demonstrated.

In addition to enhancing the quality of graphene devices, polyolefins exhibit good mechanical stability, flexibility, and deformability. These properties make this class of polymers suitable for flexible and moldable substrates for graphene devices. We demonstrate the potential of this approach by fabricating simple biosensors that can be molded directly onto the skin.

Keywords: graphene, electronic devices, ultrahigh carrier mobility, charged impurities

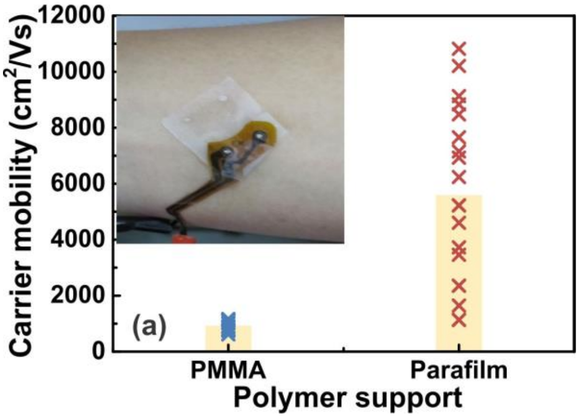

Figure 1: Comparison of Hall mobility of graphene on traditional polymeric support layers (PMMA) and polyolefins (Parafilm)

References:

K. S. Novoselov, V. Fal, L. Colombo, P. Gellert, M. Schwab and K. Kim,(2012) A roadmap for graphene, *Nature*, 490, 192-200.

Y. Zhang, V. W. Brar, C. Girit, A. Zettl and M. F. Crommie,(2009) Origin of spatial charge inhomogeneity in graphene, *Nat Phys*, 5, 722-726.

Strategy towards alignment of conjugated polymer chain for high-mobility transistors

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Abstract:

One of the reasons for low charge carrier mobility in solution-processed conjugated polymers is the random packing of polymer chains and the amorphous nature of the polymer film due to the entanglement of polymer fibres, stochastic nucleation, fluid dynamics in wet film deposition and drying mechanisms. In order to improve the chain alignment, techniques such as mechanical rubbing, dip coating, zone-casting and Langmuir-Blodgett deposition were employed in the past. In this talk, I will present our some recently developed techniques— capillary action-mediated film deposition and nanogrooves-assisted slot-die coating, for a long-range (close to microscopic scale) alignment of conjugated polymer. It was observed that, in both techniques, the uniaxial, fine nanogrooves fabricated on the dielectric surface facilitate the unidirectional solution flow which is the main driving force towards the macroscopic alignment in the polymer film. The chain alignment renders the anisotropic charge transport along the backbone, yielding a high charge carrier mobility in the field-effect transistors. The Atomic Force Microscopy images, polarized UV-Vis absorption spectrum, and X-ray diffraction spectrum also verify the long-range alignment in the polymer film. In addition to strategy for high-mobility transistors, the applications of polymer transistor in reusable medical devices and electronic skins will also be briefly discussed.

Keywords: semiconducting polymer, alignment, organic field-effect transistor, slot-die coating, reusable medical devices, electronic skins

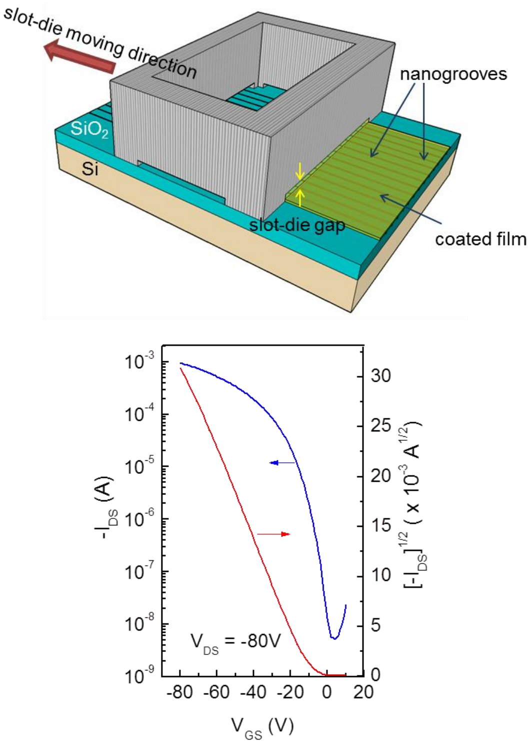

Figure 1: Figure illustrating the nanogrooves-guided slot-die coating on a silicon substrate with thermally grown silicon dioxide (top). The transfer characteristic of field-effect transistor showing the mobility of ~ 5 $cm^2/V^{-1}s^{-1}$ (bottom).

References:

Luo C., Kyaw A. K. K. and et al. (2013) General Strategy for Self-Assembly of Highly Oriented Nanocrystalline Semiconducting Polymers with High Mobility, *Nano Letters*, 14, 2764-2771

Kyaw A. K. K. et al. (2016) Nanogroove-guided slot-die coating technique for highly ordered polymer films and high-mobility transistors, *ChemComm*, 52, 358-361

Terahertz magneto-absorption and faraday rotation in electrostatically control graphene and graphene anti-dot

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Abstract:

Thanks to efficient control of its optical properties by electrostatic gating and plasmonic structure patterning, graphene has a great potential for photonic applications. In particular, the optical absorption of graphene is highly sensitive to the magnetic field, owing to the extremely small cyclotron mass of charge carriers. Moreover, the magnetically broken time reversal symmetry results in a giant Faraday rotation [1] opening avenues towards realization of graphene-based non-reciprocal devices, such as Faraday rotators and isolators, which would be fundamentally impossible in zero field.

We measured terahertz magneto-absorption and Faraday rotation in large-area CVD graphene field effect transistors, where we combined the magnetic biasing (up to 7 T) with electrostatic gating. This allowed us to achieve a rather deep magneto- and electro-modulation of graphene properties in a broad range of frequencies. Most significantly, we demonstrate the sign inversion of the Faraday rotation in ambipolar graphene transistors by using the electric field rather than the magnetic field as it is done conventionally (see figure (a)). In a second time we've studied similar graphene samples, patterned in a square lattice of periodic anti-dot. The patterning gives rise to strong magnetoplasmonic modes, which can be used to enhance magneto-optical effects at desired frequencies while keeping the possibility of electrostatic control (see figure (b)) [2]. Overall, our results show a feasibility of fast-tunable graphene-based terahertz magneto-optical modulators and non-reciprocal devices.

Keywords: graphene, plasmonic structure, tunable giant Faraday rotation, magnetoplasmonic, non-reciprocal devices, square lattice of periodic anti-dot.

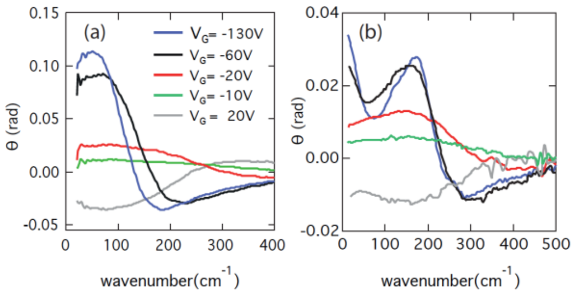

Figure 1: Faraday rotation in radian for (a) unpatered graphene (b) Square lattice anti-dot array at different gate voltages.

References:

1. Crassee, J. Levallois, A. L. Walter, M. Ostler, A. Bostwick, E. Rotenberg, T. Seyller, D. van der Marel & A. B. Kuzmenko. (2011), Giant Faraday rotstion in single- and multilayer graphene, *Nature Physics*, **7** 48.
2. P. Q. Liu F. Valmorra, C. Maissen and J. Faist. (2015), Electrically tunable graphene anti-dot array terahertz plasmonic crystals exhibiting multi-band resonances, *Optica* Vol. 2, Issue 2, pp. 135-140.

Enhanced carrier transport in ad-layer-covered graphene

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Abstract:

Graphene has been heralded as an enabling material for transparent conducting electrodes that could find application in flexible electronics, next generation displays, and solar cells. The performance of currently produced graphene, however, cannot achieve industry requirements in terms of conductivity at a certain transparency (Novoselov *et al.*, 2012).

This issue arises from the lack of guidelines for graphene optimization. Chemical vapor deposition, for example, can produce graphene with widely varying morphologies by controlling domain size and layer number(Li *et al.*, 2013) but limited understanding exists on which morphology is most suitable for electrode applications.

We here demonstrate that graphene ad-layers, i.e. discontinuous islands of graphene on top of a main layer, are representing a morphology that is enhancing graphene's performance. Previously, these ad-layers have been considered ineffectual on graphene transport based on simplifying assumptions of negligible interaction between layers and significant effort had been invested in suppressing their growth.

We devised two methods to produce graphene ad-layers with controllable concentration. First, the density of ad-layer nucleation sites could be finely controlled by the conditions of electropolishing treatment of the growth substrate as identified by theoretical modeling and by atomic force investigation of the grown graphene. Secondly, controlled pressure CVD was employed to influence the growth conditions of the ad-layer which resulted in tunable ad-layer coverage.

Both methods were found to continuously reduce the sheet resistance of graphene for increasing ad-layer coverage. As a result, the performance of graphene TCFs could be tripled upon optimization of the ad-layer coverage. This surprising behavior was quantitatively explained by the introduction of a low resistance parallel conduction pathway of electrons through the ad-layer.

Raman spectroscopy was employed to elucidate the origin of the high conductivity of ad-layers and an increased electrostatic doping of these regions was found.

Keywords: graphene, chemical vapor deposition, ad-layers, high conductivity

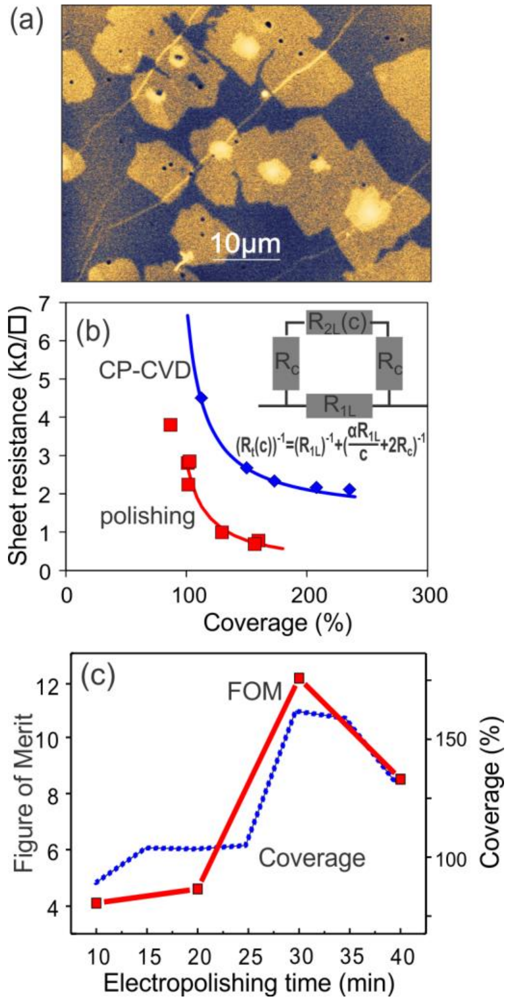

Figure 1: (a) False-color microscope image of ad-layer-covered graphene, (b) ad-layer coverage-dependent resistance for two production methods (inset) equivalent circuit, (c) comparison of pre-treatment effect on ad-layer coverage and Figure of merit

References:

K. S. Novoselov, V. Fal, L. Colombo, P. Gellert, M. Schwab and K. Kim,(2012) A roadmap for graphene, *Nature*, 490, 192-200.

Q. Li, H. Chou, J.-H. Zhong, J.-Y. Liu, A. Dolocan, J. Zhang, Y. Zhou, R. S. Ruoff, S. Chen and W. Cai,(2013) Growth of adlayer graphene on Cu studied by carbon isotope labeling, *Nano letters*, 13, 486-490.

Surface Engineering of Pt submonolayer on Au Nanostructure by ion adsorption-*in situ* electrochemical reduction for Fuel Cell Application

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Abstract:
A facile design of Pt nanostructures from submonolayer to monolayer has been realized by ion adsorption–*in situ* electrochemical reduction on Au nanoparticles supported on multiwall carbon nanotubes (CNTs). The as prepared Au@Pt/CNTs catalysts display coverage-specific electrocatalysis. The halide mediated adsorption for different Pt halides were studied and a coverage and species dependent surface enginnering for the submonolayer were investigated. Their corresponding electrocatalysis towards cathodic oxidation of various compounds has also been explored. It was found that this highly reproducible process can precisely controlled AuPt mixed metal surface with specific ratio and hence electrochemical properties which allows large scale preparation without tedious protocols. The influence of the choice of different Pt halides on the final catalytic properties will also be discussed.

Keywords: 1) Direct Liquid Fuel Cell 2) Electrocatalysis 3) Platinum 4) Gold 5) submonolayer

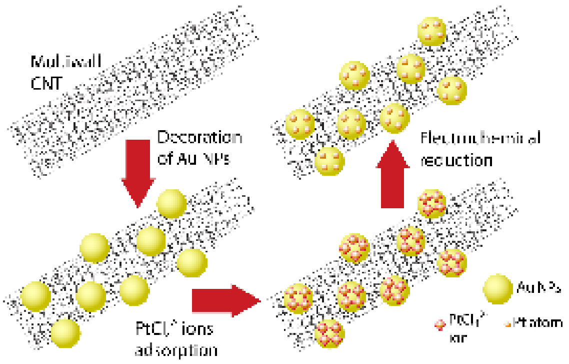

Figure 1: Preparation scheme of Au@Pt/CNTs composite.

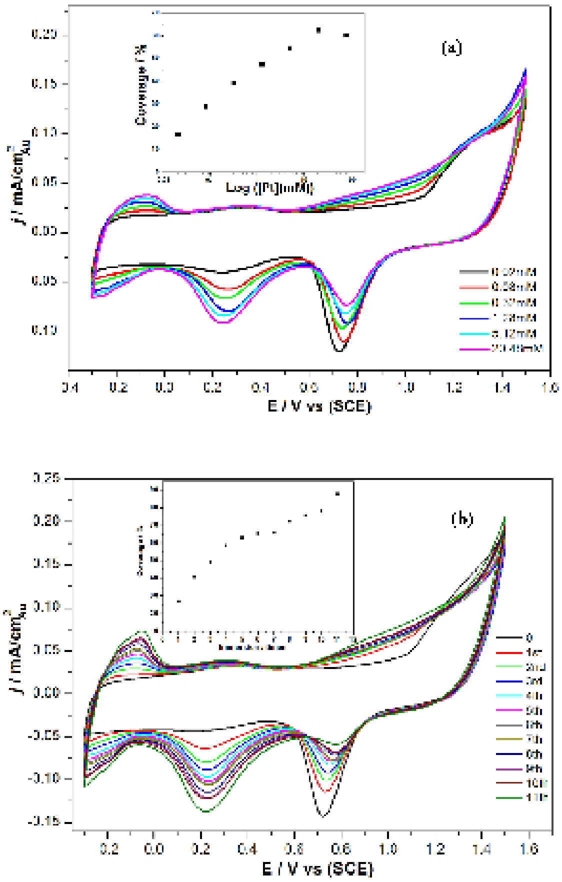

Figure 2: CVs of Au@Pt/CNTs in 0.1M H_2SO_4 prepared in 0.1M H_2SO_4 containing K_2PtCl_4 of different concentrations (a) and consecutive ions adsorption – in situ electrochemical reduction times in 0.08mM - 5.12mM K_2PtCl_4 + 0.1M H_2SO_4 (b) both are at a scan rate of 50mV/s.

References:

F. Zheng, W.-T. Wong* and K.-F. Yung***** (2014) “Facile Design of Au@Pt Coreshell Nanostructures: Formation of Pt Submonolayer with Tunable Coverage and Their Applications in Electrocatalysis” Nano Research, 7, 410-417.

Fabrication and Structural Optimization of Porous Single-crystal α-Fe_2O_3 Microrices for High-Performance Lithium-ion Battery Anode

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Abstract:

Three-dimensional (3D) porous frameworks have great promise on the field of lithium-ion batteries (LIB). However, the size effects which 3D porous frameworks have on the structural and functional optimization are rarely reported. Herein, porous single-crystal α-Fe_2O_3 microrices synthesized through a facile one-pot hydrothermal method have been developed as a model system to investigate the correlations between pore structure and LIB performance. A top-down chemical etching method was used to control the pore size and porosity of the α-Fe_2O_3 microrices simultaneously over a wide range. The α-Fe_2O_3 porous microrices were further coated with carbon to stabilize the structure. The electrochemical characterizations show that the increase of the pore size and the total porosity leads to a higher specific capacity but poorer cycling performance. Carbon coating on the surface of α-Fe_2O_3 microrices significantly enhance the structural stability of particles and improve the cyclability of batteries. The obtained α-Fe_2O_3@C porous microrices exhibit a high capacity of ~1107 mAh g^{-1} at a current density of 200 mA g^{-1}, 83% capacity retention after 100 cycles and an excellent rate capability, which are among the best ones so far reported for α-Fe_2O_3 electrodes. Our results provide a general structural optimization strategy of porous oxides for high performance LIB anodes.

Keywords: single-crystal, α-Fe_2O_3 microrices, lithium-ion battery.

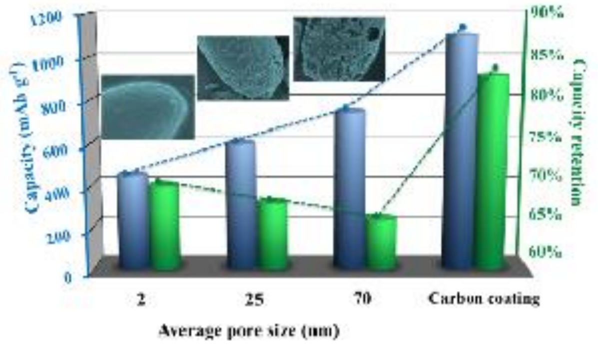

Figure 1: The porous framework is constructed via a top-down chemical etching approach. Tuning pore size and porosity by the reaction parameters enables systematically investigation of structural optimization of α-Fe_2O_3 porous microrices for LIBs application. Particularly, the pore size and porosity of microrices are found to increase simultaneously during the etching process. The electrochemical properties of as-synthesized porous α-Fe_2O_3 with different pore size have been conducted to reveal the correlations between the pore size/total pore volume and the capacity/cycling life.

References:

1. B. Z. Yu, X. L. Liu, H. G. Zhang, G. Y. Jing, P. Ma, Y. Luo, W. M. Xue, Z. Y. Ren, Fan, H. M. *J Mater. Chem. A*, **2015**, 3, 16544-16550.
2. W. Bao, B. Yu, W. Li, H. Fan, J. Bai, Z. Y. Ren, *Journal of Alloys and Compounds*, **2015**, 647, 873-879

Session/Topics you are interested in: Smart Materials, Nanomaterials

Nanoelectrode Array Formation by Electrolytic Nanoparticle Impacts

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Abstract:

A new rapidly developing method of nanoparticle (NP) sizing is the electrochemical detection of single NPs in solution by impact voltammetry. This novel technique allows for the quantitative in situ characterization of suspended NPs. As a NP collides with an electrode under Brownian motion, it is electrolyzed at a suitable potential. The number of electrons transferred during the electrolysis allows for quantitative sizing information, while the potential required for electrolysis provides information on the composition.

We report the quantitative sizing of metal halide NPs through the impact voltammetry of suspended AgBr NPs. In addition, we shows that by reducing AgBr to Ag on impact at an electrode surface, it is possible to form Ag nano deposits of similar size to the incident NP at the site of collision. By altering the timescale of the nano-impact experiment we show it is possible to alter the coverage of the nanodeposits to create a random ensembles of Ag nanoelectrodes. By SEM imaging no aggregation of the deposits is observed. This is a significant improvement over common methods such as drop-casting which often results in aggregatation of the NPs on the electrode surface.

The Ag nanoelectode array is successfully characterized electrochemically by the electrocatalytic reduction of hydrogen peroxide, H_2O_2, and behaves as a random ensemble of Ag nanoelectrodes with overlapping diffusion layers. This is a simple method for the fabrication of nanoelectrode arrays and can be applied to a wide range of materials.

Keywords: nanoparticle, nanoelectrode, array, sizing, electrochemistry.

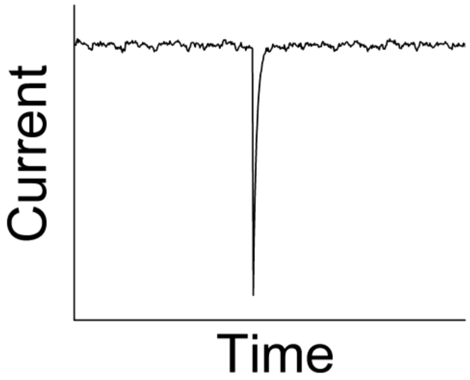

Figure 1: Example of a current-time transient for an impacting NP

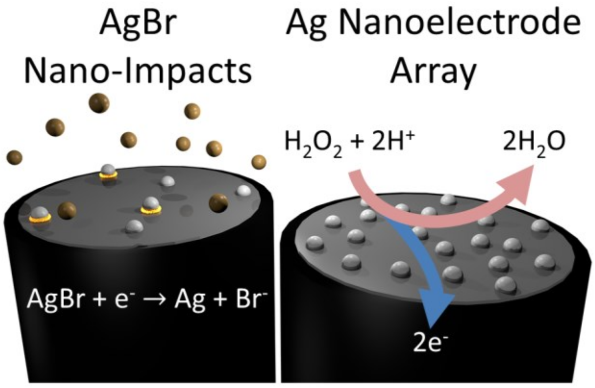

Figure 2: Figure illustrating the formation of a Ag nanoelectrode array by the electrolysis of individual AgBr NPs impacting on the electrode surface.

References:

Bartlett, T. R., Sokolov, S. V., Compton, R. G. (2015) Electrochemical Nanoparticle Sizing Via Nano-Impacts: How Large a Nanoparticle Can be Measured?, *ChemistryOpen.*, 4, 600-605.

Bartlett, T. R., Holter, J., Young, N., Compton, R. G. (2016) Nanoelectrode Array Formation by Electrolytic Nanoparticle Impacts, *Nanoscale.*, published online, DOI: 10.1039/C5NR08872K.

$ZnFe_2O_4$ nanoparticles synthesis by laser pyrolysis: interest as new anode material for lithium-ion batteries

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[2]School of Materials Science and Engineering, Nanyang Technological University, Singapore
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Abstract:
The development of portable devices, electric vehicles and renewable energies has motivated research works about energy storage for years. Existing lithium-ion batteries cannot reach sufficient energy density to address the needs for such applications. One of the issues limiting the energy density is the low specific capacity of the graphite anode (372 $mAh.g^{-1}$).

Mixed-transition metal oxides with a spinel structure (AB_2O_4 – A, B transition metals) appear as a promising solution to replace graphite with a higher theoretical capacity (between 750 and 1000 $mAh.g^{-1}$). Nanostructuration of these compounds was studied to maintain mechanical stability and to enhance lithiation kinetics. $ZnFe_2O_4$ is an interesting substitute to graphite as the storage mechanism gives rise to a theoretical capacity of 1001 $mAh.g^{-1}$ and among various oxides, $ZnFe_2O_4$ is cheap, abundant and non-toxic.

Compared with oxides like Fe_2O_3, the combination of two transition metals contributes to lower the working voltage vs. Li/Li^+ (1.5V for $ZnFe_2O_4$ vs. 2.1V for Fe_2O_3).

$ZnFe_2O_4$ nanoparticles were synthesized by laser pyrolysis. In this process, an aerosol containing precursors droplets produced by a nebulizer, is flown into the reactor with a carrier gas. In the reactor, a 10.6 µm-CO_2 laser beam decomposes the precursors to obtain nanopowders which are then collected on a filter. The key advantage of laser pyrolysis is the ability to obtain nanomaterials in large scale with a high purity while controlling the grain size with the appropriate parameters.

Solutions containing $Zn(NO_3)_2.6H_2O$ and $Fe(NO_3)_3.9H_2O$ dissolved in deionized water were used for the synthesis of $ZnFe_2O_4$ nanoparticles. Ethylene was used as sensitizer gas to absorb the CO_2 laser and allow the decomposition of the precursors whereas air and argon were tested as carrier gases. Powders of different morphologies and crystallinities were obtained and characterized by XRD, SEM, EDX, HRTEM and XPS. ZnO and Fe_2O_3 were also synthesized to compare their electrochemical performances with those of $ZnFe_2O_4$. All the results were compared with literature.

Keywords: $ZnFe_2O_4$, nanoparticles, laser pyrolysis, energy storage, lithium-ion battery, anode

Synthesis of Binder Free Graphene@MnO2/PANI nanocompsite for electrode material in high performance supercapacitors

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Abstract:

Due to rapid consumption of fossil resources and rapidly increasing environmental concerns, role of renewable energy conversion and storage devices has become very vital. For energy storage applications, lithium ion batteries and supercapacitors are the ultimate solution. There have been much research focus on electrode materials for supercapacitors, such as, carbon, metal oxides and conducting polymers. In our current study, we have synthesized binder free, graphene@MnO_2/PANI nanocomposite by simple hydrothermal method, to use as electrode material for high performance supercapacitors. The graphene was grown on nickel foam by CVD method act as conducting substrate for synthesize binder free nanocomposite electrode material. As synthesized nanocomposite exhibits, three different type of nanostructures on the surface of 3D grown graphene, as shown in Figure, i.e. PANI nanosheets (red arrows), agglomeration of MnO_2 nanostructures (green arrows) and PANI nanofibires coated with MnO_2 nanostructures (yellow arrows). The electrochemical performance was significantly improved up to 1500 charging discharging cycle, and it might be due to activation of porous nanocomposite electrode material. Maximum galvanometric charging discharging specific capacitance (SCs) of activated nanocomposite was recorded to be 1370 Fg^{-1} at current density of around 3 Ag^{-1} and cyclic voltammetry specific about 2734 Fg^{-1} at scan rate of 0.5 mVs^{-1}.The cycle reversibility was over 90% relative to maximum SCs value up to 3000 charging discharging cycles. The composite materials exhibited excellent rate capability higher than 70% with current density from 3 Ag^{-1} to 15 Ag^{-1}. Charge transfer mechanism has been studied in great detail in current study.

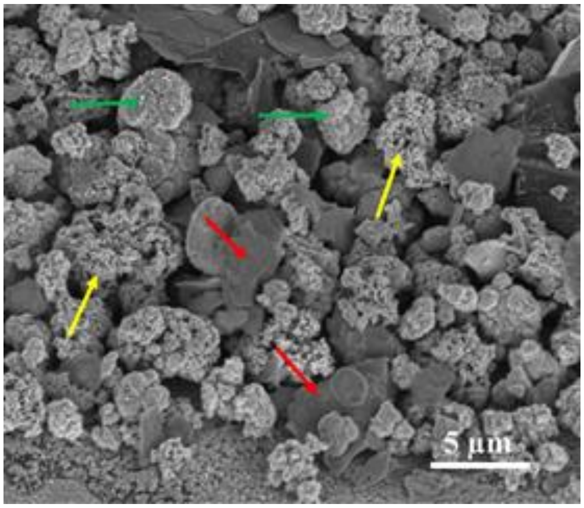

Figure 1: SEM image of graphene@MnO2/PANI nanocomposite electrode material for supercapacitors.

Scalable production of graphene with adjustable electronic properties by electrochemical intercalation and exfoliation

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[2] Department of Material Science and Engineering, National Cheng Kung University, Tainan, 70101, Taiwan

Abstract:

Graphene, a monolayer of graphite, is uniquely suited for flexible electronics due to its high transmittance and special electrical properties. To improve the commercial potential of the material, solution-processed thin films of graphene flakes are of particular interest.

We here demonstrate the electrochemical exfoliation of natural graphite into graphen as a cost efficient and promising route for high quality graphene films. A significant advantage over existing techniques the ability to tailor the properties of graphene produced by electrochemical exfoliation through control of the process parameters. In-situ measurements and spectroscopic characterization are used to provide insight into the exfoliation mechanism and its relation to the properties of thus produced graphene. It was found that the thickness, defectiveness and flake size can be adjusted over wide ranges by choice of suitable exfoliation parameters and electrolytes

Despite the advantages of electrochemical exfoliation, the achievable TOC performance is below industry requirements, which is due to graphene's low intrinsic carrier concentration. Consequently additional doping strategies are required to overcome this issue.

The second part of this contribution demonstrates the performance enhancement of exfoliated graphene films by a preceding intercalation step. Strong and stable doping could be achieved through intercalation of the graphite precursor with iron (III) chloride in aqueous solution. The effect of doping was found to be strongly dependent on the intercalation potential and the work function of the resulting graphene material could be adjusted between 4.8 and 5.2eV. Spectroscopic characterization reveals a gradual change of intercalant bonding character with intercalation potential as the origin of this behavior. The resulting graphene flake films are found to exhibit a threefold improvement in performance over pristine graphene flake films. Doping stability over one year was observed which makes the electrochemical intercalation a promising route towards high performance graphene materials for practical applications.

Keywords: graphene, electrochemical exfoliation, graphite intercalation, transparent conducting films

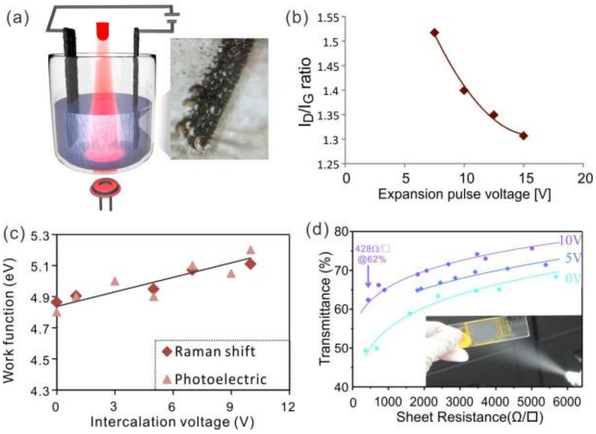

Figure 1: (a) Schematic of the electrochemical intercalaiton and exfoliation experiment, (b) dependence of graphene defectiveness on exfoliation parameters, (c) relation between graphene work function and intercalation voltage, (d) performance of graphene-based transparent conductors at varying intercalation conditions

References:

Bae, S., Kim, H., Lee, Y., Xu, X., Park, J. S., Zheng, Y., Balakrishnan, J., Lei, T., Kim, H. R., Song, Y. I., Kim, Y. J., Kim, K. S., Ozyilmaz, B., Ahn, J. H., Hong, B. H., Iijima, S. (2010), Roll-to-roll production of 30-inch graphene films for transparent electrodes, *Nature nanotechnology*, 5, 574-8.

Nair, R. R., Blake, P., Grigorenko, A. N., Novoselov, K. S., Booth, T. J., Stauber, T., Peres, N. M., Geim, A. K. (2008), Fine structure constant defines visual transparency of graphene, *Science*, 320, 1308.

Novoselov, K. S., Geim, A. K., Morozov, S. V., Jiang, D., Zhang, Y., Dubonos, S. V., Grigorieva, I. V., Firsov, A. A. (2004), Electric field effect in atomically thin carbon films, *Science*, 306, 666-9.

Chaves, A. J., Lima, G. D., de Paula, W., Cordeiro, C. E., Delfino, A., Frederico, T., Oliveira, O. (2011), Dynamical gap generation in graphene nanoribbons: An effective relativistic field theoretical model, *Phys. Rev. B*, 83, 153405.

Hofmann, M., Chiang, W. Y., Nguyen, T. D., Hsieh, Y. P. (2015), Controlling the properties of graphene produced by electrochemical exfoliation, *Nanotechnology*, 26, 335607.

The conference session/topic: Smart Materials

Pyroelectric, ferroelectric, piezoelectric and dielectric properties of $Na_{0.5}Bi_{0.5}TiO_3$ ceramic processed by sol-gel method

N.A. Halim, T.S. Velayutham, W.H. Abd. Majid

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Abstract:
Sodium bismuth titanate (NBT) nanopowder of molar composition 50/50 ($Na_{0.5}Bi_{0.5}TiO_3$) was prepared by a modified sol-gel processing method. The evolution of the structure and microstructure of the precursor gel as well as, the ferroelectric, pyroelectric, dielectric and piezoelectric properties of the NBT were studied. NBT with average particle size of 50 nm and crystalized on the rhombohedra perovskites structure $Na_{0.5}Bi_{0.5}TiO_3$ were obtained from the precursor gel by heating at 700°C, 2 hours in air. The NBT ceramic present good dielectric properties (ε'= 953, tan δ = 0.037, T_c=370°C), piezoelectric properties (d_{33}=74pC/N, k_p=0.35), high remnant polarization (P_r = 47μC/cm^2) and coercive field (E_c= 55kV/cm) and high pyroelectric coefficient 707μC/m^{2}K. Hence, the sol-gel prepared NBT could be used for silicon based memory device application, where a low synthesis temperature is a key requirement.

Keywords: pyroelectric, ferroelectric, sol-gel processes, $Na_{0.5}Bi_{0.5}TiO_3$ ceramic, smart material

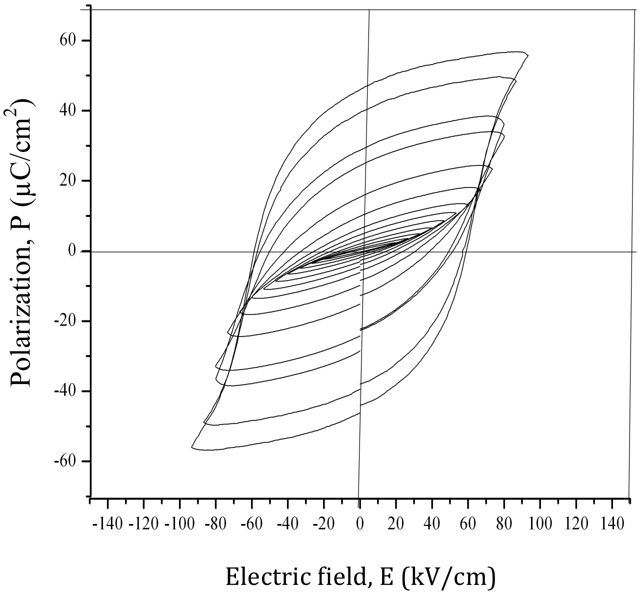

Figure 1: Room temperature P-E hysteresis loops of NBT ceramic measured at 200 Hz with varied electric field

References:

Zheng P, Zhang JL, Tan YQ, Wang CL. (2012) Grain-size effects on dielectric and piezoelectric properties of poled BaTiO3 ceramics. *Acta Mater* **60**: 5022–30.

Marin Cernea, Bogdan S.Vasile, Claudio Capiani, Anghel Ioncea, Carmen Galassi. (2012) Dielectric and piezoelectric behaviours of NBT-BT0.05 processed by sol gel method. *Journal of the European Ceramic Society* 32:133-139.

ZnO-based UV detector performance improvement

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Abstract:
Sensors of UV radiation are important elements of many systems in the defense and aerospace industries. Thus, it is a remarkable goal to improve the basic parameters of these devices. ZnO is one of the possible alternatives for currently used materials in UV detection applications. This transparent material has the optical band gap of 3.37 eV, which enables to detect radiation with a wavelength of about 375 nm (Zamburg *et al.*; 2012). We report the investigation of an influence of deposition process' parameters, upon the UV detection performance of nanocrystalline ZnO films. Films were produced by aerosol assisted chemical vapor deposition. (Yoon *et al.*; 1998) By varying the temperature and the type of substrate we controlled crystallographic structure of ZnO film, and, as a result, photosensitivity. Eight samples were produced. Four samples were grown on amorphous ITO under temperatures 300°C, 350°C, 400°C and 450°C. Investigation of the parameters of these samples showed, that it is necessary to use two temperatures: 300°C and 420°C. We produced four more samples: on sapphire under 300°C, on sapphire under 420°C, on sapphire under 300°C with introduction of Pt and on Si under 300°C with introduction of Pt. These are sample 5, 6, 7 and 8, respectively. Structural and electrical properties of the films were studied. Figure 1 shows XRD patterns of samples 5-8. We report production of the detector with a high photoresponse and discuss how substrate, Pt nanoparticles and deposition temperature influence photosensitivity of ZnO films obtained by AACVD process. Also, results are compared with some other published studies (Transley, Neeley; 1984).

Key words: ZnO, thin film, UV detector, AACVD

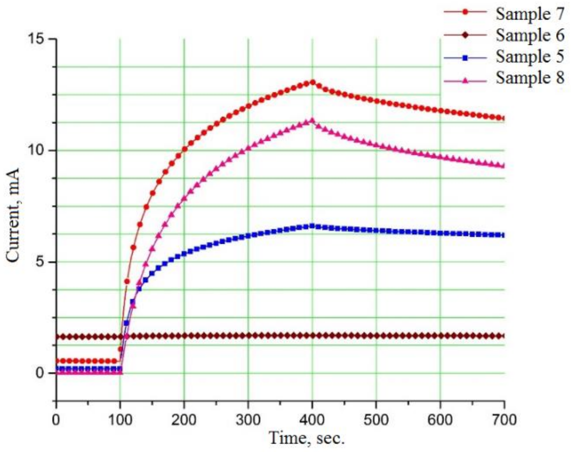

Figure 1 Current-on-time characteristics of samples 5-8. It shows slow growth and decline of photocurrent in samples 5, 7 and 8 and almost no response in sample 6

Referances:

Ageev O.A., Dostanko A.P., Golosov D.A., Zavadski S.M., Zamburg E.G., Vakulov D.E., and Vakulov Z.E. (2014), Electrical and optical properties of zinc-oxide films deposited by the ion-beam sputtering of an oxide target, *Semiconductors*, vol. 48, №9, P. 1242–1247.

Jong-Gul Yoon, Hun Kyoo Oh, Young Jik Kwag (1998), Structural and optical properties of TiO2-SiO2 composite films prepared by aerosol-assisted chemical-vapor deposition, *Journal of the Korean Physical Society*, vol. 33, №6, P. 699-704.

Tansley T.L., Neely D.F. (1984), Adsorption, desorption and conductivity of sputtered zinc oxide thin films, *Thin Solid Films* №121, P. 95-107.

Quaternized Polyphenylene oxide/TiO_2 anionic composite membranes for application in alkaline polymer electrolyte fuel cells

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Abstract

Anion exchange composite membrane fabricated from poly (phenylene oxide) (PPO) containing ammonium groups then doped with TiO_2 nanoparticles (QPPO/TiO_2) for application in alkaline polymer electrolyte fuel cells (APEFCs) is described. The characteristics properties of the QPPO/TiO_2 composite membrane were investigated with X-ray diffraction and TGA analysis. The chloromethylation of PPO confirmed by ^{1}H NMR. The successful introduction of both chloromethyl and the quaternized ammonium in the aryl position was confirmed by FT-IR spectroscopy. The membrane morphology was observed by SEM studies. Figure 1 shows the surface difference of chlorinated PPO (CPPO), QPPO and QPPO/1.5%TiO_2. Figure 1 shows successfully modification of PPO membrane. Figure 1 (A) shows a smooth surface with pores on the surface, Figure 1 (B) shows the surface grafted with quaternary ammonium groups indicating succefully fabrication of QPPO (Gopi *et al*, 2014) as confirmed by the FT-IR. When the TiO_2 nanoparticles were introduced, a smoother surface was obtained with clear visibility of the nanoparticles (Nemati *et al*, 2015, Nonjola *et al*, 2013). The above Figure 1 shows a succefully fabrication of QPPO/TiO_2 membranes. To study the effect of TiO_2 loading on the anion exchange membrane, the TiO_2 loading was varied from 0-1.5% wt. When evaluating the intrinsic properties, water uptake increased with an increase in TiO_2 loading and contact angle also increased. The ion exchange capacity and ionic conductivity increased as the TiO_2 loading was increased. Observation of the results suggest that QPPO doped with nanocomposite have a good prospect for possible use in APEFCs (Vinodh *et al*, 2011).

Key words: Alkaline polymer electrolyte fuel cell, Composite membrane, TiO_2 nanoparticles, Polyphenylene oxide (PPO)

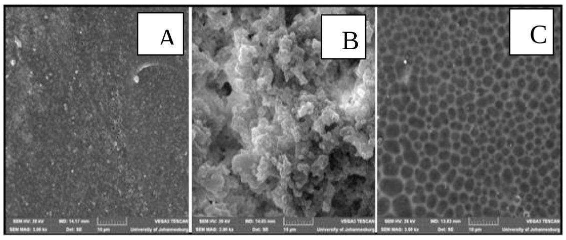

Figure 1: Surface morphology images of (A) CPPO, (B) QPPO and (C) QPPO/1.5%TiO_2 membranes.

Reference:

1. Gopi K., Peera S., Bhat S., P Sridhar, Pitchuma S. (2014), Preparation of Polyphenylene oxide (PPO) as anion exchange membrane for alkaline polymer fuel cells, *Int. J. Hydrogen energy*., 39, 2659-2668.
2. Nemati M., Hosseini S., Bagheripour E., Madaeni S. (2015), Electrodialysis heterogeneous anion exchange membrane filled with TiO_2 nanoparticles: Membranes fabrication and characterisation, *J. Membr . Sci. Research*., 1,135-140.
3. Vinodh R., Purushothaman M., Sangeetha D. (2011), Novel quaternized polysulfone/ZrO_2 composite membranes for solid alkaline fuel cell applications, *Int. J. Hydrogen energy*., 36, 7291-7302.
4. Nonjola P., Mathe M., Modibedi R. (2013), Chemical modification of polysulfone: Composite anionic exchange membrane with TiO_2 nano-particles, *Int. J. Hydrogen energy*., 38, 5115-5121.

Oil Removal from Produced Oil Using Graphene

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Abstract

Oil and gas industries has to deal with a large amount of produced water (PW) as a wastewater. Treatment and Disposal of PW is a major environmental concern. Thus, technologies are being improved to help in meeting the required environmental regulations at lower cost. Adsorption was found to be most effective technique to remove oil from water. Graphene as nanoparticles, has been extensively and successfully used in the treatment of wastewater. In this study, we report on the use of nano graphene as an adsorbent for the removal of emulsified oil from produced water. Several batch tests were performed on produced water to find the optimum removal efficiency in terms of adsorbent dosage, equilibrium time, pH, temperature and salinity. The optimum conditions are; contact time = 60 minutes, initial pH = 10, graphene dosage =3.0 $(\frac{g}{L})$, salinity = 1500 ppm and temperature 25℃ with a maximum removal efficiency of 80%. Adsorption isotherms are obtained and the experimental data are found to fit Freundlich isotherm with adsorption capacity of 100.08 $(\frac{mg}{g})$. The adsorption kinetic of emulsified oil is described by the pseudo-second–order kinetic model with a rate constant of 0.0198$(\frac{g}{mg.min})$. Regeneration of graphene was achieved by n-hexane as a solvent, and was reused for another cycle of adsorption. Results showed that the removal efficiency of emulsified oil by regenerated graphene decreased from 80 % to 75 %. These results are discussed in light of the chemical composition of oil and their interaction with graphene.

Keywords: Produce Water, Graphene, Wastewater, adsorption, Equilibrium Isotherms

Humidity Sensing Investigation of Copper-Palladium Nano-structures

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Abstract:

Nanostructures plays a critical role for the sensing applications, because they have properties unique from their bulk equivalents (Singh *et al.*; 2014, Jaiswal *et al.*; 2015). Present work is concerned about the humidity sensing behaviour of bimetallic Cu/Pd nanostructures. Herein, bimetallic Cu/Pd nanostuctures have been prepared in aqueous solution by chemical reduction method. The prepared Cu/Pd nanostructures have been characterized by X-ray diffraction (XRD), scanning electron microscope (SEM) and transmission electron microscope (TEM) for their structural and surface morphological properties. Further, a thin film of bimetallic Cu/Pd nanostructures has been fabricated via spin-coating method. Fabricated film is, then, investigated for sensing properties towards humidity. For the humidity sensing investigations, the fabricated film was exposed with humidity in the humidity sensing chamber and corresponding variations in electrical resistance with relative humidity (%RH) were observed (Figure 1). After the exposure of humidity the variations in electrical resistance of sensing film were measured using Keithley Electrometer (Model: 6514A). Moreover, stability of the fabricated sensor was also investigated. Stability curve of the fabricated humidity sensor indicates that the results found were reproducible after 1 month of the sensor fabrication.

Keywords: Nanostructures; thin films; adsorption.

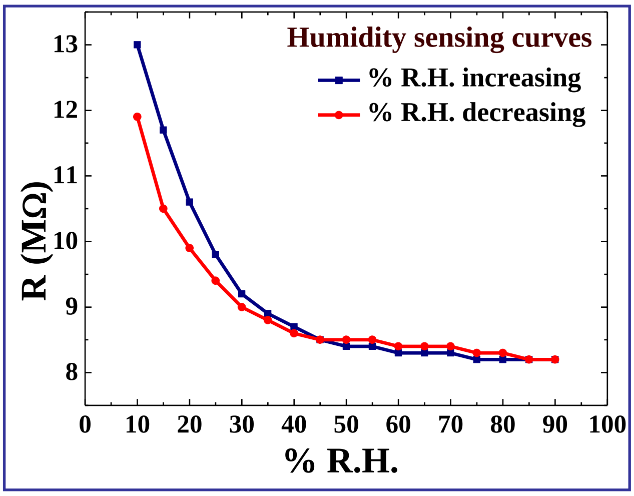

Figure 1: Humidity sensing curves of sensor based on Cu/Pd nanostructures.

References:

Singh, S., Gupta, V., Yadav, B.C., Tandon, P., Singh, A.K., (2014), Structural analysis of nanostructured iron antimonate by experimental and quantum chemical simulation and its LPG sensing, *Sens. Actuators B*, 195, 373-381.

Jaiswal, A.K., Singh, S., Singh, A., Yadav, R.R., Tandon, P., Yadav, B.C., (2015), Fabrication of Cu/Pd bimetallic nanostructures with high gas sorption ability towards development of LPG sensor, *Mat. Chem. Phys.*,154, 16-21.

Smart Heat Absorbers based on Phase Change Materials for Energy Storage in Bioclimatic Buildings

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Abstract:

The implementation of efficient energy storage systems play a crucial role in conserving the energy and smoothing out temperature fluctuation in buildings. Interestingly, for phase change materials (PCMs), thermal energy transfer occurs when the material changes from liquid to solid, or solid to liquid. Recently, PCMs have proven to excel in assuring highly effective release and storage of thermal energy. In countries where temperatures are considerably high, energy is absorbed into the PCM material and stored, changing the state of the PCM from solid to liquid. Whereas, when the PCM releases this amount of absorbed energy, its state goes back from liquid to solid. Thus, energy storage in bioclimatic buildings can be employed by means of latent heat; in presence of PCMs. Hence, in our research, the prepared polymeric composite materials are based on linear low-density polyethylene (LLDPE) as the matrix, paraffin wax as the phase change material, in addition to expanded graphite as a highly conductive filler that significantly suppressed the leakage of paraffin wax. Further, knowing the fact that plastics are being extensively used in outdoor applications, both artificial and natural weathering tests have been carefully conducted and well-studied in order to further confirm the improved thermal performance of our specimens. Surface, thermal, chemical and mechanical characterization techniques have been employed in the analysis of our energy storage PCM materials. The main objective of this work involves advanced knowledge in the areas of materials processing and sustainable energy utilization. Results have generally indicated that the leakage of phase change material was highly suppressed when adding larger portions of expanded graphite filler.

Keywords: Phase change materials, energy storage, latent heat capacity, heat absorption, paraffin wax, expanded graphite, polymeric composites.

Gas Sorption Kinetics in the Confined Space of Nano-Pores of Metal-Organic Frameworks

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Abstract:

Adsorption kinetics of gas molecules in the confined space of Nano-pores is an important scientific issue besides the thermodynamic properties for gas sorption. The understanding of gas sorption kinetics can provide fundamental perspectives for gas sorption behaviors in the nano-pores of adsorbents, and it will be of great importance for a wide range of applications including gas storage and separation. Metal-organic Frameworks (MOFs) is an emerging type of crystalline inorganic-organic hybrid materials which have attracted extensive attentions around the world. The flexibility in tuning the pore structure combined with the uniform pores of MOFs provides us ideal platforms to study the sorption kinetic behaviors of gases. In this paper, the adsorption kinetics for CO_2, CH_4 and N_2 in the Nano-pores of MOFs are investigated. The results demonstrate that the diffusional behavior of CO_2 and CH_4 in the pores of MOFs follows the stretched exponential (SE) model. The properties of gas molecules and the dimensions of pores are the key parameters of adsorption kinetics for gases. The diffusional rate of CH_4 which has a larger molecular dimension, exhibits a much higher diffusion rate than CO_2. In the pores with windows larger than 0.5 nm, the diffusion rates of all these gases are fast. The combined studies of thermodynamic isotherms, kinetics, adsorption enthalpies and activation energy of gas sorption reveal that the diffusional barrier of gas molecules along the surface of pores rather than the constrictions in the pore windows is the rate controlling step for the whole gas sorption process.

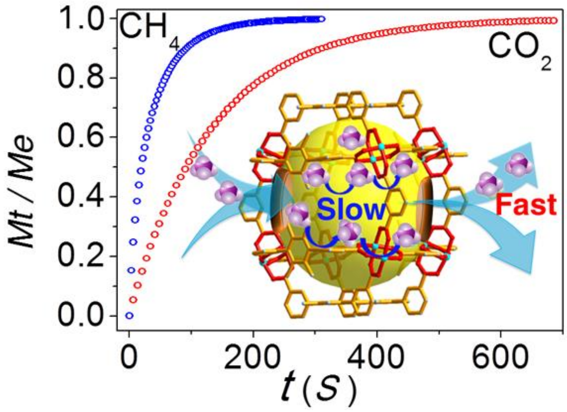

Figure 1: The illustration of diffusional behaviors of gas molecules in the nano-pores of MOFs

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Keywords: Gas adsorption, metal-organic frameworks, nano-pores, kinetics, gas storage, diffusion rate, diffusional barrier, rate controlling step.

References:

Liangjun Li., Jon G. Bell, Sifu Tang, Xiaoxia Lv, Chao Wang, Yanlong Xing, Xuebo Zhao,* K. Mark. Thomas,* et al., (2014) Gas Storage and Diffusion through Nanocages and Windows in Porous Metal–Organic Framework Cu_2(2,3,5,6-tetramethylbenzene-1,4-diisophthalate)$(H_2O)_2$, *Chem. Mater.*, 26, 4679-4695.

Liangjun Li., Haitao Xue, Ying Wang, Pinhui Zhao, Dandan Zhu, Min Jiang, Xuebo Zhao,*. (2015), Solvothermal metal metathesis on a metal-organic framework with constricted pores and the study of gas separation, *ACS Appl. Mater. Interfaces.*, 7, 25402-25412.

Effect of pH on Adsorption Capabilities and Magnetic Properties of $MnFe_2O_4$ Nanoparticles for Removal of Dye Pollutants

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Abstract:
We show that the manganese ferrite ($MnFe_2O_4$) magnetic nanoparticles have the best adsorption properties for efficient removal of dye pollutants from contaminated water. $MnFe_2O_4$ nanoparticles were synthesized by facile coprecipitation method with varing pH values of 9, 9.5, 10 and 10.5. The obtained products have been characterized by X-ray diffraction (XRD), transmission electron microscopy (TEM), fourier transform infrared spectroscopy (FTIR), Brunauer Emmett Teller (BET)-specific surface area, zeta potential, X-ray photoelectron spectroscopy (XPS), and vibrating sample magnetometer (VSM) techniques. Batch experiments were carried out to quantify the adsorption kinetics and adsorption capacities of the $MnFe_2O_4$ nanoparticles with varying pH values for removal of Methylene Blue (MB) and Rhodamine B (RhB). The adsorption data from our experiments fit the Langmuir isotherm, yielding the maximum adsorption capacity of $MnFe_2O_4$ at pH of 10.5 was higher than that of other samples for MB and RhB removal. The pH changes the surface charge of $MnFe_2O_4$ nanoparticles leading to change in surface defects, hence affect the adsorption capability. Moreover, the specific surface area, particle size, and morphology are also very important to change in adsorption capability. The $MnFe_2O_4$ nanoparticles have been shown that they can be recycled for the removal of a number of different contaminants with little or no loss of an adsorption capability. We believe that the developed $MnFe_2O_4$ nanopaticles would open up new opportunities as well as enhance their beneficial adsorption capability toward diverse applications.

Keywords: $MnFe_2O_4$, adsorption, dyes, removal, precipitation method.

Fabrication of $ZnWO_4/Bi_2WO_6$ Composite Films as Efficient Photocatalyst for Degradation of Dye Pollutants

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Abstract:
The dramatic visible light photocatalytic activity was obtained for the degradation of Methylene Blue (MB), Rhodamine B (RhB) and the mixed dyes of Methylene Blue and Rhodamine B under visible light irradiation (λ > 400 nm) over $ZnWO_4/Bi_2WO_6$ composites films fabricated by a doctor blading method. Detailed characterization through X-ray diffraction, scanning electron microscopy, X-ray photoelectron spectroscopy, UV-vis spectroscopy, atomic force microscopy, and photoluminescence techniques confirms the physicochemical properties of $ZnWO_4/Bi_2WO_6$ composite films. The as-synthesized $ZnWO_4/Bi_2WO_6$ composite films present excellent photocatalytic degradation of MB, RhB, and the mixed dyes of MB and RhB. The high photocatalytic activity came from the synergetic effect between $ZnWO_4$ and Bi_2WO_6, which promoted the migration efficiency of photogenerated carriers on the interface of $ZnWO_4$ and Bi_2WO_6. Moreover, the $ZnWO_4/Bi_2WO_6$ composites also have excellent cycling stability and superior photocatalytic performance toward dye pollutants. The detection of reactive species of the as-prepared samples were determined during the photocatalytic process. To further understand the effect of physical and chemical properties of $ZnWO_4$ and Bi_2WO_6 on the photocatalytic activity and the photocatalytic mechanism of $ZnWO_4/Bi_2WO_6$ composite photocatalyst were discussed.

Keywords: $ZnWO_4/Bi_2WO_6$, composite, metal oxide; methylene blue; rhodamine B; photocatalytic activity.

Ultrathin Mussel-inspired Solvent Resistant Nanofiltration Membranes

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Abstract:

Many efforts have been devoted to improve nanofiltration membrane performance and extend their application via surface engineering. Inspired by the composition of adhesive proteins in mussels, dopamine has been utilized as a versatile and intriguing starting material for surface modification under mild conditions. [1,2]

In this work, we report for the first time the use of dopamine/terephtaoyl chloride for the fabrication of a smooth ultra-thin film composite membrane (~5.4 nm thickness) for solvent resistant nanofiltration applications by optimizing the interfacial polymerization and crosslinking techniques. We achieved excellent permeation and rejection performance using dimethylformamide solutions. The ease of chemical modification and preparation makes this bio-inspired membranes potentially easy to scale up at low cost.

The chemical crosslinking of PAN on polypropylene non-woven support with hydrazine hydrate [3] followed by interfacial polymerization using dopamine and terephtaoyl chloride, resulted in a new type of PAN solvent resistant nanofiltration membrane with an extremely thin and smooth selective layer. A solvent resistant composite nanofiltration membrane with a coating thickness below 8nm was never been reported before [4]. Moreover, no change in the morphology of the thin film composite membrane was observed in DMF even after several days of being immersed in such a harsh environment. The resulting thin-film composite membrane showed permeances up to 5 L/m^2 h bar combined with a molecular weight cut-off below 800Da.

Keywords: dopamine, terephtaoyl chloride, solvent resistant nanofiltration, thin film composite membrane.

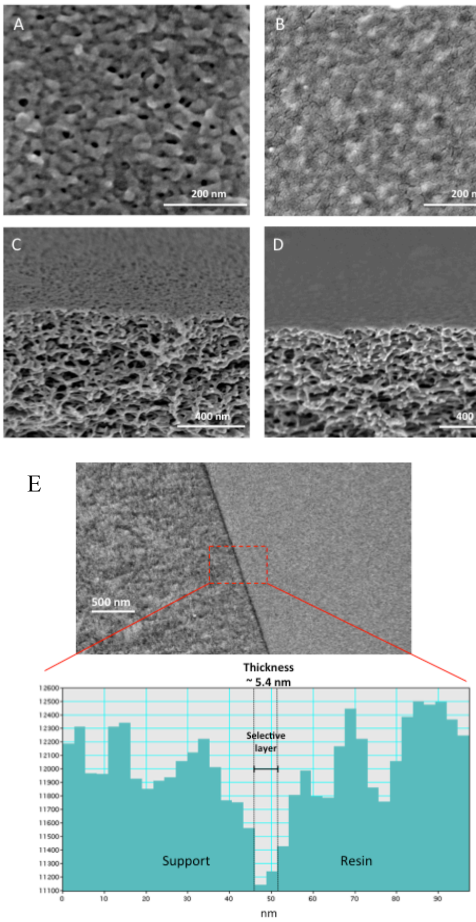

Figure 1: SEM images of surface and cross-section of crosslinked PAN (A, C), after surface modification by interfacial polymerization of dopamine/terephtaoyl chloride (B, D). TEM image of dopamine/ terephtaoyl chloride thin film composite membrane (top) and contrast histogram of the selected area (bottom) showing a thickness of ~ 5.4nm for the selective layer. Boundaries were defined as the positions where a drastic contrast change takes place.

References:

[1] H. Lee, S. M. Dellatore, W. M. Miller, P. B. Messersmith, *Science* **2007**, 318, 426.
[2] J. Zhao, Y. Su, X. He, X. Zhao, Y. Li, R. Zhang, Z. Jiang. *J. Membr. Sci*. **2014**, 465, 41.
[3] L. Pérez Manríquez , J .Aburabi'e, P. Neelakanda, K-V. Peinemann. *React Funct Polym*. **2015**, 86, 243.
[4] S. Karan, Z. Jiang, A. Livingston. *Science*. **2015**, 348, 1347.

Graphene/Polymer Nanocomposites Modified Substrates for Sensitive Biomolecular Detection

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Abstract:

Nanocomposites of graphene (G) and conducting polymer (*e.g.* polyaniline) are developed and used as novel substrates for biomolecular detection along with electrochemistry and laser desorption ionization mass spectrometry (LDI-MS). Due to the high electric conductivity, large surface area, and excellent thermal stability, G is selected to modify the electrode for increasing the electrochemical sensitivity. Moreover, strong UV absorption of G promoting the ionization efficiency of analytes in LDI-MS makes it suitable for LDI probe modification. In this research, conducting polymer type, ratio of G/polymer and fabrication parameter are optimized to achieve the desired nanocomposites. Electrospinning/spraying is employed for the fabrication of electrode and LDI probe to enhance specific surface area and conductivity of the composites. According to the preliminary results, the presence of G-polymer nanofibers/nanodroplets on electrode and LDI probe significantly increase the electric conductivity and sensitivity in LDI-MS detection (*e.g.* cholesterol, peptide biomarker). Interestingly, once nanocomposites are prepared, two powerful techniques can be used to complement as a dual-detection system. This novel approach opens a field for developing ultra-sensitive biosensor that might be very useful for medical diagnostics.

Keywords: graphene, conducting polymers, laser desorption ionization mass spectrometry, electrochemical sensor, biomarker.

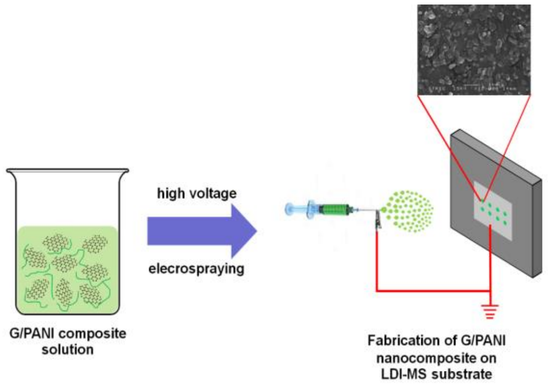

Figure 1: Figure illustrating the electrospray fabrication of G/PANI nanocomposite on substrates for electrochemistry and LDI-MS.

References:

1. Rodthongkum, N., Ruecha, N., Rangkupan, R., Vachet, R. W., Chailapakul, O. “Graphene-Loaded Nanofiber-Modified Electrodes for the Ultrasensitive Determination of Dopamine” *Anal Chim Acta.* 2013, *804*, 84-91.
2. Ruecha, N., Rangkupan, R, Rodthongkum, N., Chailapakul, O. “Novel Baper-based Cholesterol Biosensor using Graphene/Polyvinylpyrrolidone/Polyaniline Nanocomposite” *Biosens. Bioelectron.* 2014, *52*, 13-19.

Increasing the volume fraction of La (Fe, Si)13 phase in La-Fe-Si magnetocaloric alloys by directional solidification

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Abstract:

The La-Fe-Si magnetocaloric alloys are considered as a promising room temperature magnetic refrigerant. It is shown that their giant magnetocaloric effect originates from the $NaZn_{13}$-type La (Fe, $Si)_{13}$ phase. However, it is a challenge to obtain the La (Fe, $Si)_{13}$ phase through a conventional solidification. To obtain the La (Fe, $Si)_{13}$ single phase, one usually spends seven days on homogenizing the as-solidified La-Fe-Si alloys that is constituted of the α-Fe and LaFeSi phases. In this case, the annealing time is too long to meet the requirements of practical applications. Many efforts have been put to explore some advanced solidification processes for increasing the volume fraction of La (Fe, $Si)_{13}$ phase, such as melt-spun, drop-tube processing and melt-extract wires, but there is no investigation for bulk castings. In this work, we greatly increase the volume fraction of the La (Fe, $Si)_{13}$ phase in the La-Fe-Si bulk casting by a zone melting liquid metal cooling (ZMLMC) directional solidification, which is supposed to shorten the annealing time. The microstructure observation reveals that the volume fraction of the La (Fe, $Si)_{13}$ phase is about 30.5% and the remnant is the α-Fe phase. This is higher than the volume fraction (20%) of the La (Fe, $Si)_{13}$ phase in the La-Fe-Si magnetocaloric alloys prepared by the drop-tube processing. Interestingly, a composition segregation is distinctly observed in the La (Fe, $Si)_{13}$ phase, of which the Si content is about 20.3% much higher than the predicted value.

Keywords: La-Fe-Si alloys, directional solidification, La (Fe, $Si)_{13}$ phase, magnetocaloric effect.

Session III:
Smart Materials for Bio-applications

Targeted Drug Delivery to Brain Tumours Using Porous Silicon Nanoparticles

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Abstract:

Targeted approaches to deliver anti-cancer drugs have the potential to achieve improved efficacy and at the same time reduced side effects. In fact, this is one of the cornerstones of nanomedicine.

We are exploring the use of high porosity biodegradable porous silicon and genetically engineered biosilica nanoparticles that are loaded with chemotherapy drugs or siRNA and also display on the particle's periphery targeting moieties such as cell-surface antibodies recognising cognate ligands highly expressed on the surface of tumour cells.

One approach centers around porous silicon nanodiscs. The process relies on a combination of colloidal lithography and metal-assisted chemical etching. Height and diameter of the pSi nanodiscs can be easily adjusted. The nanodiscs are degradable in physiological milieu and are non-toxic to mammalian cells. In order to highlight the potential of the pSi nanodiscs in drug delivery, we carried out an *in vitro* investigation which involved loading of nanodiscs with the anti-cancer agent camptothecin and functionalization of the nanodisc periphery with an antibody that targets receptors on the surface of neuroblastoma cells. The thus prepared nanocarriers were found to selectively attach to and kill cancer cells [1]. In a second approach, we used natural nanoporous biosilica from the diatom *Thalassiosira pseudonana*. The biosilica was genetically engineered to display GB1, an IgG binding domain of protein G, on the biosilica surface, which allowed for the attachment of cancer cell targeting antibodies and the adsorption of nanoparticles loaded with anti-cancer drugs. Adherent neuroblastoma cells and B lymphoma cells in suspension were selectively targeted and killed by drug-loaded biosilica displaying specific antibodies (Figure 1). In a subcutaneous mouse xenograft model of neuroblastomamice, regression of SH-SY5Y tumour growth was evident in immunodeficient Balb/c nude mice that were when treated with drug-loaded anti-p75NTR-labelled biosilica. Histological analysis confirmed accumulation of antip75NTR-labelled biosilica in the tumours. This result established the efficacy of targeted drug-loaded-biosilica in a relevant clinical model [2]. In a final approach, we engineered porous silicon nanoparticles to deliver siRNA to successfully down-regulate drug transporter proteins in brain tumour cells [3,4]. Coating of nanoparticles with cationic polymers improved sustained DNA and siRNA release and suppressed burst release effects. In addition, polymer coating significantly enhanced the uptake of nanoparticles across the cell membrane. Histopathological analysis of liver, kidney, spleen and skin tissue collected from mice receiving nanoparticles further demonstrates their biocompatible and non-inflammatory properties.

Keywords: drug delivery, nanoporous silicon, diatom biosilica.

References:

1. H. Alhmoud, B. Delalat, A. Cifuentes, R. Elnathan, A. Chaix, O. Durand, M.-L. Rogers, N.H. Voelcker, Porous silicon nanodiscs for targeted drug delivery, Advanced Functional Materials, 25 (2015), 1137-1145.
2. B. Delalat, V.C. Sheppard, S. Rasi Ghaemi, S. Rao, C.A. Prestidge, G. McPhee, M.-L. Rogers, J.F. Donoghue, V. Pillay, T.G. Johns, N. Kröger, N.H. Voelcker (2015) Targeted drug delivery using genetically engineered diatom biosilica, Nature Communications, In Press.
3. M.H. Kafshgari, B. Delalat, W.Y. Tong, F. Harding, M. Kaasalainen, J. Salonen, N.H. Voelcker, Oligonucleotide delivery by chitosan-functionalized porous silicon nanoparticles, Nano Research, 8 (2015), 2033-2046.
4. H. Kafshgari, F. Harding, N.H. Voelcker, Small interfering RNA delivery by polyethylenimine-functionalised porous silicon nanoparticles, Biomaterials Science, 10.1039/C5BM00204D.

Organic/Graphene Based Nanomaterials and Nanodevices

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Abstract:

The success of novel molecular and material design depends on a comprehensive understanding of molecular properties and interactions. Here, we elaborate on how we have designed functional organic/graphene-based nanomaterials and nanodevices. Starting from the first CVD grown graphene [1], we exploit graphene functionalization [2] towards energy storage, and fuel cell catalysts [3], and water remediation [4]. The transport phenomena in molecular electronic/spintronic devices and graphene nanoribbon spin valves are studied using non-equilibrium Green function theory [5]. Fano-resonance driven 2D molecular electronics spectroscopy using quantum conductance spectra of a graphene nanoribbon can lead to fast DNA sequencing including cancerous methylated nucleobases detection [6,7]. Novel nano-optics phenomena are presented based on self-assembled nano-scale lenses showing near-field focusing and magnification beyond the diffraction limit [8]. Selective fullerene sensing [9] and fluorescence sensing of RNA over DNA are achieved with imidazolium compounds [10,11]. The temperature-driven transient molecular gating in covalent oirganic molecular frames can store gaseous molecules in ordered arrays toward unique collective properties [12].

Keywords: sensing, gas storage, nanolensing, graphene, fuel cell, spintronics, DNA sequencing, 2D molecular electronics spectroscopy.

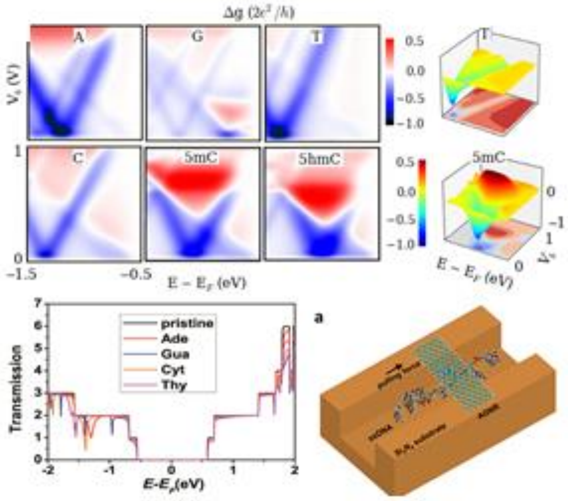

Figure 1: Fano resonance driven Two Dimensional Molecular Electronics Spectroscopy (2D MES) for molecular fingerprinting, DNA sequencing, and cancerous DNA recognition using a graphene-based nanochannel device.

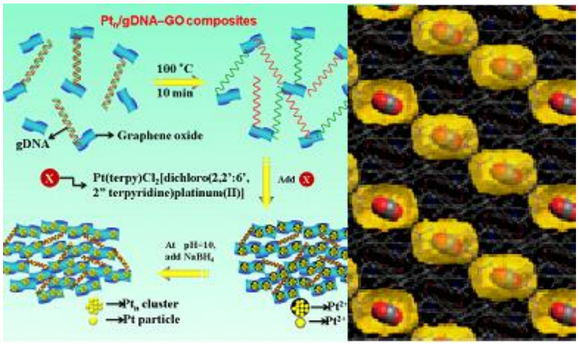

Figure 2: (left) Pt clusters (diameter ~1 nm) deposited on DNA/reduced-graphen-oxide composites as a high–performance electrocatalyst for the oxygen reduction recation (catalytic activity higher than the US DOE target value). (right) Well ordered pseudo-impermeable covalent organic framework cages with transient molecular gating for gas sorprtion and storage.

References:

1. K. S. Kim et al. *Nature* **2009**, *457*, 706.
2. V Georgakilas et al. *Chem. Rev.* **2012**, *112*, 6156.
3. J. N. Tiwari et al. *Nature Commun.* **2013**, *4*, 2221.
4. V. Chandra et al. *ACS Nano* **2010**, *4*, 3979.
5. W. Y. Kim et al. *Nature Nanotechnol.* **2008**, *3*, 408.
6. S. K. Min et al. *Nature Nanotechnol.* **2011**, *6*, 162.
7. A. C. Rajan et al. *ACS Nano* **2014**, *8*, 1827.
8. J. Y. Lee et al. *Nature* **2009**, *460*, 498.
9. Y Chun et al. *Nature Commun.* **2013**, *4*, 1797.
10. B. Shirinfar, et al. *J. Am. Chem. Soc.* **2013**, *135*, 90.
11. M. Yousuf et al. *Chem. Sci.* **2016** (in press) doi: 10.1039/C5SC03740A
12. Baeck S. B. et al. *Proc Natl Acad Sci.* **2015**, *112*, 14156.

Green Tea-Sourced Micellar Nanocomplex for Protein Delivery that Achieves Synergistic Effects

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Abstract:
The carriers of all drug delivery systems so far are just excipients for drug delivery with no relevance of therapeutic effect and can lead to problems associated with their toxicity, metabolism, and elimination (when used at high quantities). Therefore, the drug-to-carrier ratio is a limiting factor when designing drug carriers. However, if both the drug and carrier possess therapeutic effects, this issue would not be a restricting factor, and might offer the advantage of combined therapeutic effects. (-)-Epigallocatechin-3-*O*-gallate (EGCG) is a major ingredient of green tea and has been shown to possess anticancer effects, anti-HIV effects, neuroprotective effects, DNA-protective effects, etc. Here we show that sequential self-assembly of the EGCG derivative with anticancer proteins form stable micellar nanocomplexes (MNCs) that have greater anticancer effects *in vitro* and *in vivo* than free protein. The MNC is obtained by complexation of oligomerized EGCG with the anticancer protein, Herceptin, to form the core, followed by complexation of poly(ethylene glycol)-EGCG (PEG–EGCG) to form the shell (Fig. 1). The binding properties of EGCG derivatives with proteins, are the driving force for the assembly of the micellar nanocomplex. The MNC showed restraint and restoration of the protein activity upon complexation and dissociation, respectively. When injected into mice, the Herceptin-loaded MNC showed improved tumor selectivity, longer blood-half-life and reduced tumor growth more efficiently than free Herceptin. The MNC not only delivered protein drugs more effectively to the cancer cells, the combination of carrier and drug also dramatically reduced tumor growth as compared with the drug alone.

Keywords: protein delivery, drug delivery, self-assembly, nanocarrier, micelle, EGCG, Herceptin, combinational effect, tumor targeting, cancer therapy.

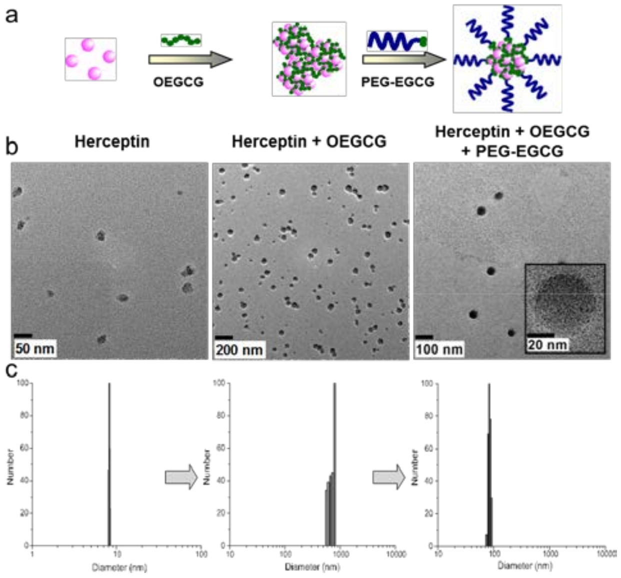

Figure 1: Schematic diagram and morphology of self-assembled MNCs loaded with proteins. a, Schematic of the self-assembly process used to form the MNCs, which are formed via two sequential self-assemblies in an aqueous solution: complexation of OEGCG with proteins to form the core, followed by complexation of PEG–EGCG surrounding the pre-formed core to form the shell. b,c, TEM images (b) and hydrodynamic size distributions (c) of complexes observed at each step of self-assembly. In the inset in the right panel in b, a high-magnification image shows a single MNC.

References:

Chung, J. E., Tan, S., Gao S. J., Yongvongsoontorn N., Kim, S. H., Lee, J. H., Choi, H. S., Yano, H., Lang, Z., Kurisawa, M., Ying, J. Y. (2014), Self-assembled nanocomplexes comprising green tea catechin derivatives and protein drugs for cancer therapy, *Nature Nanotechnology*, 9, 907–912.

Du, G. J., Zhang, Z., Wen, X. D., Yu, C., Calway, T., Yuan, C. S., Wang, C. Z. (2012), Epigallocatechin gallate (EGCG) is the most effective cancer chemopreventive polyphenol in green tea. *Nutrients* 4, 1679–1691.

Effects of Synthesis Techniques and Initials Reagent on Chemical Compositions and Microstructure of Hydroxyapatite

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Abstract:

Hydroxyapatite (HAp) has been widely recognized as a biomaterial for repairing or substituting human hard tissues such as scaffolds and artificial bones. To utilize HAp in practical applications, desired chemical compositions and fine HAp particles are required. Hydroxyapatite is generally obtained from natural bones and chemical synthesis. The aim of this study was to synthesize hydroxyapatite powder by solution combustion and solid-state reaction techniques, using chemicals and bio-wastes, specifically cockleshells, as initial reagents. Results from X-ray diffraction (XRD) indicated that the hydroxyapatite phase was observed in all powders. Microstructural analysis also revealed that average particles sizes of the powders were in the range of sub-micrometer. Nevertheless, average particle sizes of the powders synthesized by the solution combustion technique were finer than those synthesized by the solid-state reaction technique.

Keywords: hydroxyapatite, biomaterials, solution combustion synthesis, solid state reaction, bio-waste.

Effect of calcium from eggshell addition on bioactivity properties of metakaolin/calcium hydroxide blended geopolymer

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Abstract:
Geopolymer is an amorphous material in term of alumino-silicate material. Nowadays, the researchers have been developing the geopolymer as biomaterials by introducing the carbonate apatite on the surface of samples. The aim of this research was to study the effect of Ca/P ratio on bioactivity properties of metakaolin/calcium hydroxide blended geopolymers. The 0wt%, 50wt% and 60wt% fine eggshell powders were added into the geopolymers in order to increase the Ca/P ratio. Potassium hydroxide and potassium silicate were used as alkali activators. For in vitro test, it was performed with simulated body fluid (SBF) soaking for bioactivity analyze. The formation of carbonate apatite bio-layer on the 28 day soaked sample surfaces was investigated using SEM, XRD and FTIR characterization. The SEM micrographs revealed that the Ca/P ratio increased, the carbonate apatite on sample surfaces increased. FTIR results confirmed that CO_3^{2-}, PO_4^{3-} and O-H were found and indicated that there should be carbonate apatite ($Ca_{10}(PO_4)_3(CO_3)_3(OH)_2$) occurring in the geopolymers.

Keywords: metakaolin/calcium hydroxide blended geopolymer, calcium addition, eggshell, SBF soaking, carbonate apatite, biomaterials.

Dendrimer mediated bioadhesion of PLGA to soft tissues

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Abstract:
Bioadhesives are necessary in solving unmet needs in minimally invasive surgeries. Tissue fixation remains a significant challenge, owing to the difficulty of bonding hydrated tissues. Carbene precursor-based bioadhesives are in current development to form short-lived free-radicals that bond to tissue via non-specific C-H bond insertion with only N2 byproducts. In the present work dendrimer grafted with diazirine carbene precursors are evaluated towards soft tissue fixation with activation via low intensity UV light.

PAMAM dendrimers from 1st to 6th generation were grafted with 5% to 30% carbene precursor. The presence of amino, hydroxyl, and acetyl end-groups were also evaluated towards cross-linking kinetics, material properties, and adhesive strength.

Adhesive strength and hydrogel modulus could be controlled over four order of magnitude through choice of light dose, percent grafting, and PAMAM generation. More importantly, modulus could be tuned to match soft tissue substrates with low in vitro cytotoxicities and without the use of photoinitiators.

Key words: Bioadhesive, diazirine, PAMAM, dendrimer, carbene

pEDOT:Vitamin K composites: proton bonding conducting polymer + quinoid thin film electrodes

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Abstract: Quinoids have important biological significance, and their behaviour and reactivity is a matter of contemporary debate.[1] In particular the reaction of most quinoids upon reduction by 2 electrons is to bond 2 protons. Usually the investigation of this behavior takes in place using a dissolved quinoid, and electrochemical testing is dependant upon quinoid mobility in solution.

A thin film chemically modified electrode (CME) using pEDOT as a conductor and Vitamin K as a proton bonding site is manufactured. This approach of blending the quinoid with a conducting polymer is first reported here, and is an elegant method of electron delivery to the quinoid. This technique is favourable compared to the technique of using phospholipid layers, because the host material is conductive, or using a self assembled monolayer, because the host material is a 3D water absorbent electrode. The schematic of the reductive and oxidative behaviour of this electrode can be seen in Figure 1.

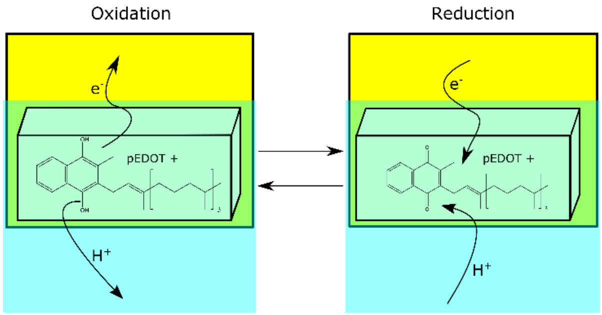

Figure 1: A schematic of the manufactured electrode's reaction with solution. Protons are bonded when the composite is reduced; and released when the composite is oxidized.

The composite manufactured exhibits very high cycle stability, with the electrodes being unchanged between cycles. The reduction peak of the quinoid was very pronounced and yields very accurate information about the redox behaviour of the quinoid under pseudo-steady state conditions, as seen in Figure 2.

When the Vitamin K is in direct contact with the electrode, the reaction is limited by the capacity of the solution to delivery of protons to the reaction site. This allows for the very sensitive measurement of the quantity of reacting protons in solution.[2] The interaction between quinoids and buffering ions is a matter of contemporary debate.[3] We demonstrate that this quinoid sensor is uniquely capable of measuring the quantity of buffering ions in solution.

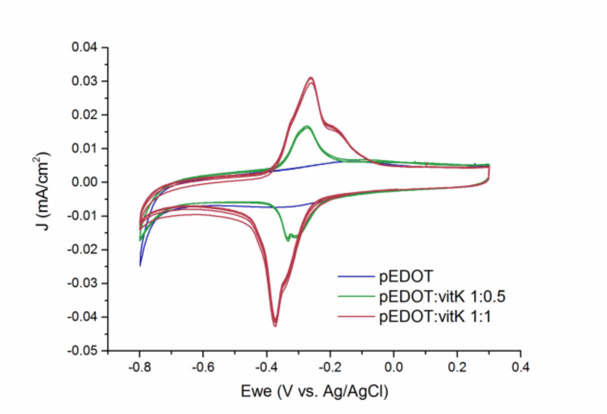

Figure 2: Cyclic voltammograms performed at 1mV/s of the manufactured electrodes with varying quantities of Vitamin K. The size of the reduction peak associated with the bonding of the quinoid is proportional to the volume fraction of quinoid in the composite.

Keywords: Conducing polymer, pEDOT, Electrochemistry, quinoid, chemically modified electrodes, proton coupled electron transfer

References:

1. Lemmer, C., Bouvet, M. & Meunier-Prest, R. Proton coupled electron transfer of ubiquinone Q2 incorporated in a self-assembled monolayer. *Phys. Chem. Chem. Phys.* **13,** 13327–13332 (2011).
2. Marchal, D., Boireau, W., Laval, J. M., Moiroux, J. & Bourdillon, C. An electrochemical approach of the redox behavior of water insoluble ubiquinones or plastoquinones incorporated in supported phospholipid layers. *Biophys. J.* **72,** 2679–2687 (1997).
3. Bonin, J., Costentin, C., Louault, C., Robert, M. & Savéant, J. M. Water (in Water) as an intrinsically efficient proton acceptor in concerted proton electron transfers. *J. Am. Chem. Soc.* **133,** 6668–6674 (2011).

NON- AND WOVEN FLAX FIBER FOR USE IN REINFORCED POLY(BUTYLENE ADIPATE-CO TEREPHTHALATE) BIO-COMPOSITES

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Abstract: Eco-friendly biocomposite materials have been developed from biodegradable polymers as matrices and natural fibers as reinforcement, which have been a good alternative interest in the composite science because of their degradation in soil or regard to environmental condition and do not emit and leave any noxious components on the earth. Great research efforts are undertaken to produce lightweight, easy reprocessable, especially biocomposites, which may compete with traditional composites in various application fields based on their favored recycling and beneficial performance/cost balance microbiology (Lee et al., 2006). The textile biocomposites made from woven and non-woven flax fibre reinforced poly(butylene adipate-co-terephthalate) (PBAT) were prepared by compression molding using film stacking method (cf-figure 1). The mechanical properties (such as tensile strength and stiffness, flexural strength and modulus, and impact strength) of textile biocomposites were determined in tensile, flexural and impact tests, respectively. The PBAT-based composites were subjected to water absorption. The comparison of the mechanical properties was made between pure PBAT and textile composites. The influence of flax weave styles on the mechanical properties was also evaluated. The results showed that the strength of the textile biocomposites was increased according to weave types of fibers, especially in the stiffness was significantly increased with the higher densification of the fibers. The 4x4-plain woven fibers (4-yard-wrap and 4-yard-weft weave direction) reinforced biocomposite indicated the highest strength and stiffness compared to the other textile biocomposites and pure PBAT. This was considered to be as the result of the character of weave style of 4x4-plain woven fibers. The aminopropyltriethoxysilane affected the mechanical properties and water absorption of the resulting composites laminates due to the surface compatibility between flax fiber and PBAT.

Keywords: biocomposites, PBAT, silane, woven flax fibers, mechanical properties, water uptake.

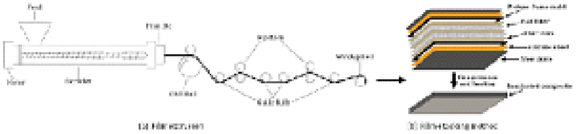

Figure 1: Schematic representation of fabrication procedure of the laminated biocomposite.

References:

Lee, S.H., Wang, S. (2006) Biodegradable polymers/ bamboo fiber biocomposite with bio-based coupling agent, Compos. Part A, 37, 80-91.

STRESS ANALYSIS OF LONG FRACTURES on HUMAN LEG BONE COMBINED WITH INTERNAL FIXATION

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Abstract:

In this study, the result of treatment of broken tibia bone with plate behavior under the pressure tensile load has been investigated numerically. The outer part of bone called cortical is selected as orthotropic and the inner part called spongioz is an isotropic material. Bottom of the broken tibia is fixed from surface of connection to talus, and pressure was applied from the upper end called femur. The gap between two parts of the fractured bone is modelled as a seperate geometry. Different modulus of elasticity, depending on the recovery time was used on gap geometry for obtaining stress effects of brekage healing both on plate and the bone. Inner surface of the connection plate was designed to take shape of the bone surface. The three-dimensional finite element method was used in numeric analysis and then tibia, plate and screws were modeled as three-dimensional models. Effects of brekage angle and brekage healing on maximum Von-Misses stresses has been investigated in static analysis.

Keywords: Internal fixation, Biomechanical, İmplants

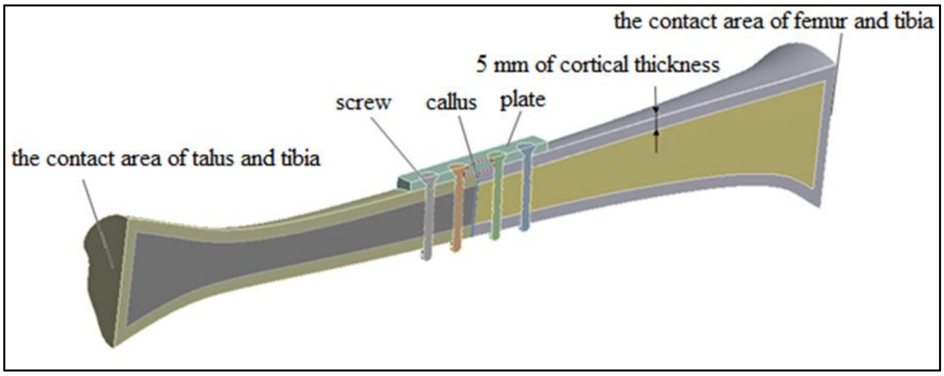

Figure 1: Figure illustrating the combining of the broken tibia bones with implants which are screws and plate. Various methods are available on the combination of bone, internal fixation is the method used in our study.

References:

1. Fouad, H., 2010. Effects of the Bone-Plate Material and the Presence of a Gap Between the Fractured Bone and Plate on the Predicted Stresses at the Fractured Bone, Medical Engineering & Physics 32 (2010) 783–789

2. Hou, S-M., and Hsu, C-C., Wang, J-L., Chao, C-K., and Lin, J., 2004. Mechanical Tests and Finite Element Models for Bone Holding Power of Tibial Locking Screws, Clinical Biomechanics 19 (2004) 738–745

Posters Session Abstracts

Investigation of ionic liquid based-carboxymethyl cellulose biopolymer electrolytes for potential application in electrochemical devices

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Abstract:
Carboxymethyl cellulose based green biopolymer electrolyte has been investigated for potential application in electrochemical devices. The carboxymethyl cellulose was obtained by reacting cellulose derived from Kenaf fiber with monochloroacetic acid. Films of green biopolymer electrolyte were prepared by solution-casting technique by adding ammonium acetate salt and butyl-trimethyl ammonium bis(trifluoromethylsulfonyl)imide ionic liquid as charge carrier contributor and plasticizer. The shift of peak of carboxyl stretching in the Fourier transform infrared spectra confirmed the interactions of host green biopolymer with the ionic liquid. Scanning electron microscopy indicated that the incorporation of ionic liquid changed the morphology of the complexes. The room temperature conductivity determined using impedance spectroscopic technique for the film without ionic liquid was 6.31×10^{-4} S cm^{-1} while the highest conductivity of 2.18×10^{-3} S cm^{-1} was achieved for the film integrated with 20 wt% butyl-trimethylammonium bis(trifluoromethanesulfonyl) imide. This proved that the insertion of ionic liquid into the salted system improved the conductivity. The improvement in conductivity was due to increase in ion mobility. The results of linear sweep voltammetry showed that the electrolyte was electrochemically stable up to 3.07 V.

Keywords: carboxymethyl cellulose, green biopolymer electrolytes, ionic conductivity, linear sweep voltammetry.

Highly Efficient Carbon-nanotube/Platinum Based Microrockets

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Abstract:

In recent years, considerable research efforts has been focused on the motion of synthetic mi-croscale objects.(Paxton et al; 2004, Ozin et al; 2005, Wang et al; 2009) Especially chemically powered micro-motors which exhibit efficient self-propulsion in the presence of hydrogen peroxide(H2O2) fuel has cap-tured great attention. (Paxton et al; 2004, Ozin et al;2005)Among chemically powered micromotors, bubble-propelled microrockets could be operation in diverse (salt-rich) matrices which offers an attractive promise for various real-life applications. Besides, as speed is essential for micro-rockets' performance, increasing the speed at low concentration chemical fuel is significant for micro-rockets applied in diverse applications. CNT has cap-tured much attention of the scientific community due to its attractive electronic and mechanical prop-erties, and it has been applied in many energy or sensing applications. As a result, CNT-induced acceleration of catalytic nanowires has been reported, while, the average speed is only 50~60 μ m/s, and the nanowire can only propelled in non-ion evrionment due to the self-electrophoresis machenism.

Here, we demonstrate a highly efficient PEDOT/CNT-Pt microrockets prepared by template-assisted electrodeposition. On one hand, the bubble-propelled microrockets can be powered efficiently in more complex environment (salt-rich); on the other hand, they can perform dramatic enhanced propul-sion at the same level chemical fuel compare to the microrockets without CNT. The speed of such CNT modified microrockets can reach 1600 μm/s at 3% H2O2. Even with 0.1% H2O2, the average speed is still around 50 μm/s. The loading of the CNT and the H2O2 concentration are greatly influent the per-for-mance of such new microrockets. In order to ap-ply-ing microrockets in diverse practical applica-tions, directional control has been easily realized. The fa-vorable propulsion behavior of such powerful PEDOT/CNT-Pt microrockets hold great promise toward various practical applications.

Keywords: microrocket, carbon nanotube, bubble-driven, hy-drogen peroxide, high efficient.

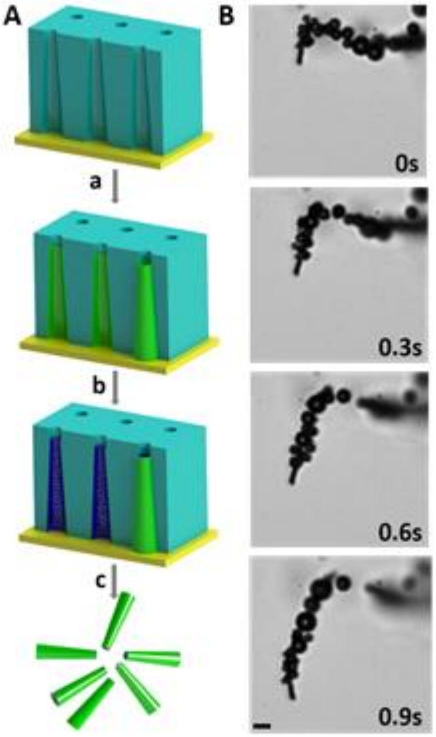

Figure 1: (A)Preparation of PEDOT/CNT-Pt mi-crotube using polycarbonate membranes: (a) depos-iton of PEDOT microtube, (b) depositon of CNT-Pt microtube, and (c) dissolution of the membrane and release of PEDOT/CNT-Pt microrockets. (B)Time-lapse imag-es(0.3s intervals) of the motion of PEDOT/CNT-Pt microrocket in the presence of 0.1% H2O2 solution, sodium dodecyl sulfate(sds) 1% scale bar, 10μm.

References:

1. 1. Paxton, W. F., Kistler, K. C., Olmeda, C. C., Sen, A., St. Angelo, S. K., Cao, Y., Mallouk, T. E , Lammert, P. E Crespi, V. H. (2004). Catalytic nanomotors: autono-mous movement of striped nanorods. J. Am. Chem. Soc.,126, 13424-13431.
2. Ozin, G. A., Manners, I., Fournier‐Bidoz, S., Arsenault, A. (2005). Dream nanomachines. Adv. Mater., 17, 3011-3018.
3. Wang J. Can man-made nanomachines compete with nature biomotors?[J]. ACS nano, 2009, 3: 4-9.

Rapid Heat Treatment Synthesis of Reduced Graphene Oxide Uniformly Decorated with Nickel Oxide Nanoparticles for Antioxidant Activities

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Abstract:

A simple method was developed for the preparation of reduced graphene oxide nickel oxide (NiO@rGO) nanocomposite using the rapid thermal reduction for the antioxidant activity towards 1-1-Diphenylpicrylhydrazyle (DPPH). The analyses of UV-visible spectra, XRD, Raman, XPS and TEM confirmed the simultaneous reduction of graphene oxide (GO) and formation of nickel oxide nanoparticles (NiONPs) on the rGO sheets. A uniform distribution of spherical NiONPs with 8.30 nm in size was homogenously embedded on the rGO layer. The spectral and colorimetric methods were performed for the antioxidant activity. The temporal change of absorption intensitiy and the color change of DPPH solution were observed during antioxidant activity. Because of the high specific surface area, rGO served as a host material for the growth of large number of NiONPs. The rGO layer prevents the aggregation of NiONPs and hence, the surface area of a NiONPs could be fully available for the interaction of DPPH. The NiO@rGO nanocomposites exhibit excellent antioxidant activity compared to the stand alone NiO NPs (Saikia *et al*., 2010) (Madhu *et al*., 2013). Furthermore, this work provides a simple platform for the development of NiO@rGO nanocomposite.

Keywords: Nanocomposites, carbon materials, antioxidant, heat treatment, radical scavenging, spectrophotometric.

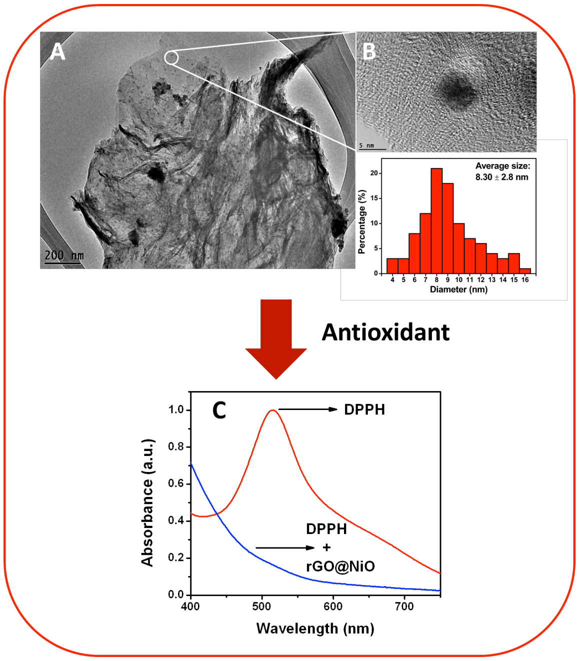

Figure 1: Figure illustrating (a) a uniformly distributed of ultrafine NiONPs on rGO sheets, (b) HRTEM image of single NiONPs and (c) a significant changes in the concentration of DPPH monitored by studying the maximal absorption peak at the 514 nm before and after the addition of NiO@rGO nanocomposites.

References:

Saikia, J. P., Paul, S., Konwar, B. K., Samdarshi, S. K. (2010), Nickel oxide nanoparticles: A novel antioxidant, *Colloids. Surf. B Biointerfaces.,* 78, 146-148.

Madhu, G., Bose, V. C., Aiswaryaraj, A. S., Maniammal, K., Biju, V. (2013), Defect dependent antioxidant activity of nanostructured nickel oxide synthesized through a novel chemical method, *Colloids. Surf. A Physicochem. Eng. Asp.,* 429, 44-50.

Solution-processable Low-bandgap 3-Fluorothieno[3,4-b]thiophene-2-carboxylate-based Conjugated Polymers for Electrochromic Applications

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Abstract:

In this paper, a series of low-bandgap donor-acceptor (D–A) conjugated polymers with 3-fluorothieno[3,4-b]thiophene-2-carboxylate (**FTT**) as an acceptor and ethylenedioxythiophene (**EDOT**) (**P1**), acyclic dioxythiophene (**AcDOT**) (**P2**) or propylenedioxythiophene (**ProDOT**) (**P3**) as donors were synthesized *via* Stille polymerization. The resultant polymers have good solubility in organic solvents. The polymers were characterized by gel permeation chromatography (GPC), nuclear magnetic resonance spectroscopy (NMR) and thermogravimetric analysis (TGA). Their electrochemical, morphological and electrochromic (EC) properties were investigated, and their absorption-transmission type electrochromic devices (ECDs) were fabricated and characterized. In their neutral states, the polymers displayed deep magenta (**P1**) to blue (**P2**, **P3**) hues, and upon electrochemical oxidation, they revealed grey tones with good optical contrasts (19-37 and 57-58% in visible and near-infrared (NIR) regions, respectively), good coloration efficiencies (158-380 and 279-378 cm^2/C for visible and NIR regions, resepctively) and reasonable redox stability (retaining 64-80% original optical contrast after 1000 cycles) under ambient conditions and without any encapsulation of the ECDs.

Keywords: Low-bandgap, solution-processable, 3-fluorothieno[3,4-b]thiophene-2-carboxylate, ethylenedioxythiophene (**EDOT**), acyclic dioxythiophene (**AcDOT**), propylenedioxythiophene (**ProDOT**) (**P3**).

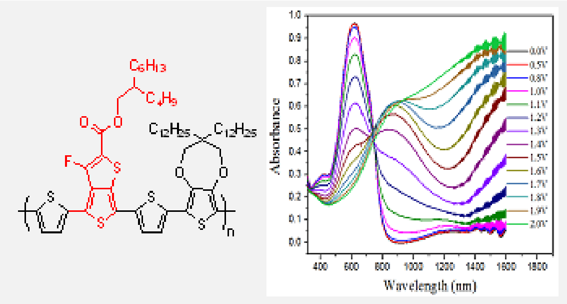

Figure 1: Spectroelectrochemical graph of **P3** device at various applied potentials.

References:

1. Neo, W. T., Shi, Z., Cho, C. M., Chua, S.-J., Xu, J. (2015), Effects of chemical composition, film thickness, and morphology on the electrochromic properties of donor-acceptor conjugated copoymers based on diketopyrrolopyrrole, *ChemPlusChem*, 80, 1298-1305.
2. Shi, Z., Neo, W. T., Lin, T. T., Zhou, H., Xu, J. (2015), Solution-processable Low-bandgap 3-Fluorothieno[3,4-b]thiophene-2-carboxylate-based Conjugated Polymers for Electrochromic Applications, *RSC Adv.*, 5, 96328-96335.

Co_3O_4/nitrogen-doped graphene/carbon nanotubes: An innovative ternary composite with enhanced electrochemical performance

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Abstract:

A ternary composite, Co_3O_4 nanoparticles/N-doped graphene (NG)/carbon nanotubes (CNTs), has been synthesized by a simple hydrothermal method. N-doped graphene nanosheets were used as the substrate with excellent conductivity and a well conductive network is established through introducing CNTs. Due to the synergetic effects of Co_3O_4 nanoparticles, N-doped graphene and embedded carbon nanotubes, the Co_3O_4/NG/CNTs electrode exhibits enhanced electrochemical performance than those of Co_3O_4/NG, Co_3O_4/graphene, which have a high specific capacitance of 456 F/g at a current density of 1 A/g. Additionally, a capacitance increase of 23.2% of the initial capacitance is observed after 1000 cycles at a current density of 1 A/g. The results provide a general strategy to design and prepare innovative ternary composites with 0-dimensional, 1-dimensional and 2-dimensional complex structures for diverse structure-sensitive applications.

Keywords: Co_3O_4, N-doped graphene, carbon nanotubes, supercapacitor

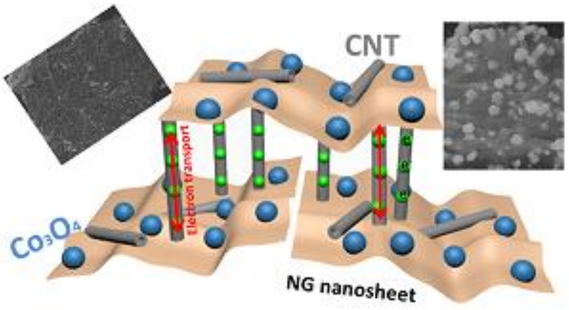

Figure 1: Schematic representation of structure and energy storage characteristics of the Co_3O_4/NG/CNTs composite.

References:

W. Bao, B. Yu, W. Li, H. Fan, J. Bai, Z. Y. Ren, *Journal of Alloys and Compounds*, **2015**, 647, 873-879

Synthesis of ^{57}Co diffused Rh composite for application of Mössbauer source

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Abstract:
To establish the coating conditions for ^{57}Co, non-radioactive Co ions are dissolved in an acid solution and electroplated on to a rhodium (Rh) plate. Then, the thermal diffusion of electroplated Co into a Rh matrix was studied to apply a ^{57}Co Mössbauer source. Nanocrystalline Co particles were coated on a Rh substrate using DC electrodeposition at a pH of 10 and 25 mA/cm^2. The particles on the Co sheet had a spherical shape. The electroplating of Co was not possible at and above current density of 30 mA/cm^2, because large amounts of salts in the solution were also coated on the Rh substrate. The current density was determined at 20 mA/cm^2. The proposed prototype for the synthesis could be applied to the electroplating radioactive ^{57}Co. The ^{57}Co is produced by ^{58}Ni(p, 20)^{57}Co, and ^{58}Ni (p, pn)^{57}Co using cyclotron irradiation. The bath was primarily composed of 0.01 M Co ions in a Hydrazine bath. The effects of the pH on the average particle size of the deposits were investigated using XRD and SEM techniques. The diffusion degree was evaluated by mapping using scanning electron microscopy (SEM). The influence of different annealing conditions was investigated. The diffusion depth of Co depends on the annealing temperature and time. The results obtained confirm that the deposited Co diffused almost completely into a Rh matrix without a substantial loss at an annealing temperature of 1200~ 1400 ℃ for 4 hours. The prepared ^{57}Co/Rh sources were capsulated for applying Mössbauer source.

Keywords: Mössbauer Source, Difussion, Electroplating, ^{57}Co/Rh

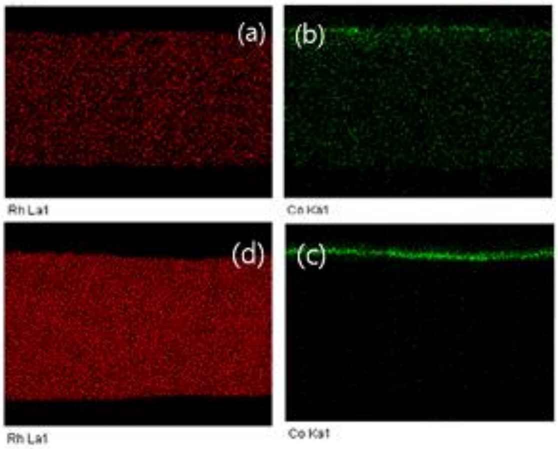

Figure 1: Mapping images of EDS for the cross section of (a) Rh and (b) Co atoms annealed at 1100 ℃ for 3h in vacuum , and (c) Co and (d) Rh atoms before annealing for the Co/Rh foil.

References:

1. Cieszykowska, M. Żóttowska, and M. Mielcarski, (2011) Electrodeposition of carrier-free ^{57}Co on rhodium as an approach to the preparation of Mössbauer sources, *Applied Radiation and Isotopes* 69 142-145.
2. Y. R. Uhm, K. Y. Park, and S. J. Choi (2015), The effect of current density and saccharin addition on the grain size of electroplated nickel, *Res. Chem. Intermed.* 41 4141-4149.
3. Izabela Cieszykowska, Małgorzata Zółtowska, Piotr Zachariasz, Andrzeja Piasecki, Tomasz Janiak, and Mieczysław Mielcarski (2011), Thermal dissusion of 57Co into thodium matrix as a second step in preparing Mossbauer sources, *Applied Radiation and Isotopes*, 69 1193-1197.

Structural Characteristics of Rolled-up Si Micro/nanotubes Prepared by Anodization

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Abstract:

Micro/nanotubes have potential future applications as transport channels and storage cells for biomedical devices [1]. In addition, tubes formed on Si surfaces have the advantage of being connected to a Si integrated circuit. Furthermore, the hydrophilicity of Si can be controlled by surface treatment such as with H_2-N_2 plasma. However, fabricating three-dimensional structures such as tubes on Si surface is a challenging process, requiring sophisticated and complex fabrication techniques. To this end, we have discovered a novel technique that fabricates rolled-up Si micro/nanotubes on a Si wafer through simple anodization. We have previously studied the shape control and the formation mechanism of these tubes [2]. This study examines the structural characteristics of the Si tube in greater detail, with the end goal of device application. Si tubes were fabricated by anodization using a mixed aqueous solution of extremely dilute HF and surfactant as an electrolyte solution. The tube was formed from a p-type crystalline Si wafer with a (100) crystal face. The tube is formed through curling of the Si surface during anodization. Figure 1 shows FE-SEM images of the Si tubes formed on the Si wafer. It was confirmed that the length and the cavity diameter of the tube were on the micro/nanometer size scale. Close-up SEM images of the edge of the tube are shown in Figure 2. It was observed that the tube has a rolled-up structure when the acceleration voltage of electron gun is 7 kV (high accelerating voltage). We confirmed the cross-sectional structure of the tube by TEM, which showed that the tube was formed by repeatedly folding over the Si wafer. The thickness of the film is approximately 10 nm, and the number of folds is 10. In addition, the TEM image shows that the tube might have an amorphous structure. Figure 3 shows a SEM image and element mapping image by EDS of the Si surface featuring the tubes. A large number of oxygen atoms exist on the tube, which are not seen on the flat Si surface. This result indicates that the tube is composed of Si oxide, which is hydrophilic and biocompatible. From these results, the tube is likely to be amorphous SiO. It is well known that the mechanical strength of amorphous materials is generally higher than that of crystalline materials derived from the same elements. Hence, our tube may have the same mechanical characteristics as a spring because of its rolled-up structure. Current research by this group is focused on the hardness and Young's modulus of the tubes as determined by nanoindentation. In the near future, our tubes could be applied to micro/nanoscale biomedical, bioelectronic and biomechanical devices.

Keywords: Si micro/nanotube, Micro/nanostrucuture, Structual characteristics, Anodization.

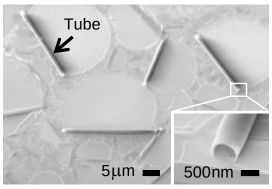

Figure 1: FE-SEM image of Si tubes: The length of the tube and the diameter of the cavity are 10 – 25 μm and 500 nm, respectively. The tube has 10 layers, and the layer thickness is approximately 10 nm.

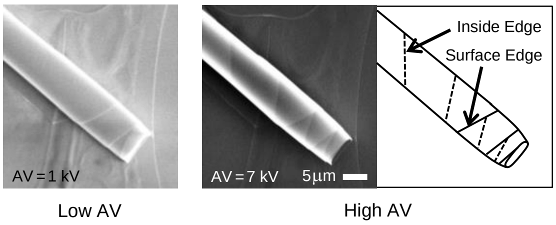

Figure 2: The relationship between FE-SEM images of the Si tube and electron accelerating voltage (AV) of the electron beam gun. The internal structure of the tube was observed at high accelerating voltages.

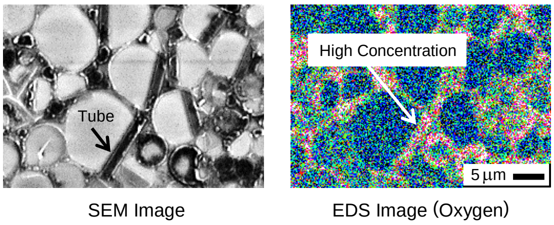

Figure 3: SEM-EDS images of the Si tubes, which indicate a large presence of oxygen atoms in the tubes.

References:

[1] K. Takei, et al., (2009), Out-of-plane microtube arrays for drug delivery– liquid flow properties and an application to the nerve block test, *Biomed Microdevices*, **11**, 539–545.

[2] T. Shimizu, et al., (2015), Preparation of mesoscopic silicon roll and its formation mechanism, *2nd Japan-Korea International Symposium on Materials Science and Technology 2015* (*JKMST2015*), Tokyo, P5, 71−74.

Synthesis of Nanoparticulate Ti-doped ZnO by Solution Combustion Technique

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Abstract:

ZnO and TiO_2 have been widely accepted as prominent photocatalysts. Enhancement of their photocatalytic activities can be achieved through particle refinement and doping. Solution combustion technique is a simple and cost-effective method capable of producing nano-sized ceramic powders with homogeneous chemical compositions. It is, therefore, employed in this research project as a technique to synthesize Ti-doped ZnO. Results from x-ray diffraction indicated that Ti-doped ZnO powders with 1.0, 3.0, 5.0, and 7.5 at% Ti had single phase with all peaks corresponded to ZnO. Equiaxial particles, with the average particle sizes ranging from 47 to 55 nanometers, were observed from the SEM micrographs.

Keywords: ZnO, TiO_2, Nanoparticles, Combustion synthesis

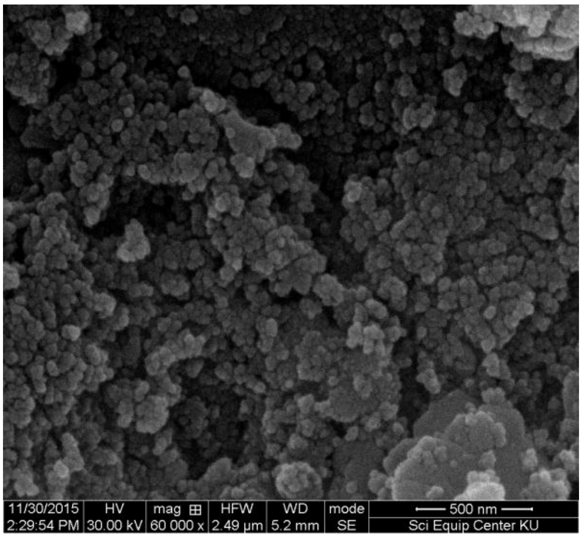

Figure 1: A scanning electron micrograph showing Ti-doped ZnO with 1.0 at% Ti powder prepared by solution combustion technique

References:

Ahn., B.D., Kang., H.S., Kim., J.H., Kim, G.H., Chang H.W., Lee., S.Y., (2006) Synthesis and analysis of Ag-doped ZnO, *Journal of Applied Physics*, 100, 093701

Hyan-Lung, C., Ching-Mei, W., (2012) Solution combustion synthesis of TiO_2 and Its use for fabrication of photoelectrode for dye-sensitized solar cell, *Journal of Materials Science & Technology*, 28, 713–722.

Jongprateep, O., Puranasamriddhi, R., Palomas, J., (2015) Nanoparticulate titanium dioxide synthesized by sol–gel and solution combustion techniques, *Ceramics International.*, 41, S169-S173.

Single Crystalline Hematite (α-Fe_2O_3) Nanocubes Prepared by One-Pot Hydrothermal Approach: The Structural and Optical Properties

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Abstract:

High quality single crystal hematite (α-Fe_2O_3) nanocubes with average dimensions of 40 nm were successfully synthesized by a facile one-pot hydrothermal method. Systematic analysis were performed to investigate the morphological-, structural- and optical-properties of the as-synthesized α-Fe_2O_3 nanocubes. The nanocrystals of α-Fe_2O_3 possess rhombohedral corundum structure with lattice parameter of 0.56352 and 1.37568 nm and Fe^{3+} ions occupy 2/3 of its octahedral sites that are confined by the nearly ideal hexagonal closed-pack O lattice (Wu et al., 2013; Zeng et al., 2007). The SAED pattern indicates the α-Fe_2O_3 nanocubes are single-crystalline in nature with lattice-fringes that are well-correlate with the standard α-Fe_2O_3. Electron micrographs show the α-Fe_2O_3 are indeed produced in high-yield and has well-defined cubical shape with average edge-length of 40 nm. Raman and XRD reveals the signature of pure α-Fe_2O_3. The SAED, electron micrographs, Raman and XRD spectra have been illustrated in Figure 1. The optical characterization reveals that α-Fe_2O_3 nanocubes show strong visible-light absorption with band gap energy of 2.1 eV while the photoluminescence emission spectra depicts a mono-peak centered at ~590 nm. The as-synthesized α-Fe_2O_3 is indeed high quality that potentially to be used as a visible-light active nanomaterial in the renewable-energy devices application.

Keywords: hematite; single crystal; nanocubes; hydrothermal; characterization

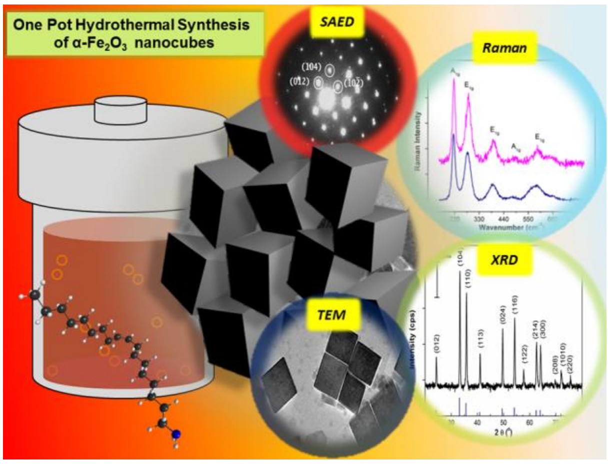

Figure 1: Brift illustration on SAED, electron micrographs, Raman and XRD spectra of single crystal α-Fe_2O_3 nanocubes synthesized by a facile one-pot hydrothermal method.

References:

Wu, W., Hao, R., Liu, F., Su, X., & Hou, Y. (2013). Single-crystalline α-Fe_2O_3 nanostructures: controlled synthesis and high-index plane-enhanced photodegradation by visible light. *Journal of Materials Chemistry A, 1*(23), 6888-6894.

Zeng, S., Tang, K., & Li, T. (2007). Controlled synthesis of α-Fe_2O_3 nanorods and its size-dependent optical absorption, electrochemical, and magnetic properties. *Journal of colloid and interface science, 312*(2), 513-521.

Preparation of self-cleaning TiO_2/SiO_2 double layer thin films by sol-gel method

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Abstract:

The self-cleaning properties of the TiO_2(top)/SiO_2(under) double layer films prepared by sol-gel method was investigated. Thin films were prepared by spin-coating onto glass and then thermally treated at different temperatures, and characterised using X-ray diffraction (XRD), atomic force microscopy (AFM), scanning electron microscopy (SEM) and UV-Visible spectroscopy. The cross-sectional structure of the films was observed by an SEM analysis (Figure 1(a)). The upper TiO_2 layer has a thickness of ca. 75 nm with a base SiO_2 layer of ca. 215 nm. The surface roughness of the films was characterized by AFM (Figure 1(b)). The root mean square surface roughness of the thin films was below 2 nm; which should enhance their optical transparency [1]. The photo-induced super-hydrophilicity of the films were evaluated by water contact angle measurement in air. The prepared thin films showed very good hydrophilicity. The stable Si–OH groups and the photocatalytic TiO_2 layer maintains the hydrophilicity of the double layer films by decomposing organic contaminants on the film surface [2]. Optical measurements reveal a high transparency of the prepared thin films (Figure 1(c)). The photocatalytic activity of the films was studied by the photocatalytic degradation of methylene blue under UV light irradiations. The TiO_2/SiO_2 double layer thin films are plausibly applicable for developing self-cleaning materials in various applications such as windows, solar panels, cement, and paints.

Keywords: Sol-gel method, SiO_2, TiO_2, thin films, photocatalysis, methylene blue

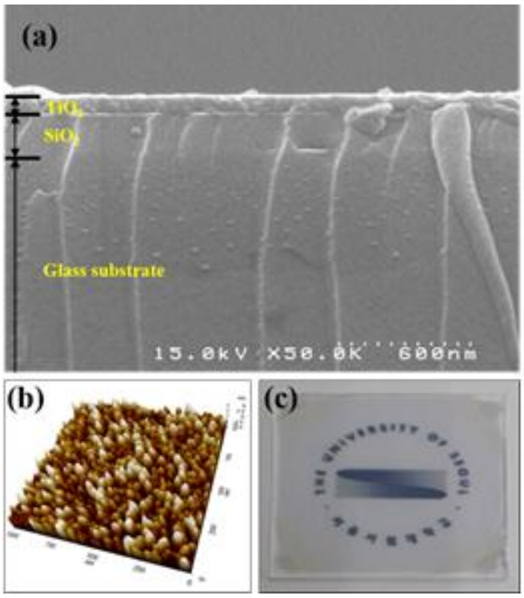

Figure 1. (a) Cross-sectional SEM image and (b) AFM image of the thin film, (c) a photograph of a glass slide showing transparency.

Reference:

1. Bensouici, F., Souier, T., Iratni, A., Dakhel, A. A., Tala-Ighil, R., & Bououdina, M. (2014). Effect of acid nature in the starting solution on surface and photocatalytic properties of TiO_2 thin films. *Surf. Coat. Technol.*, 251, 170–176.
2. Nakamura, M., Kobayashi, M., Kuzuya, N., Komatsu, T., Mochizuka, T. (2006) Hydrophilic property of SiO_2/TiO_2 double layer films. *Thin Solid Films* 502, 121–124.

Ni-Ti Shape Memory Alloy Sheet Part Stretch Formed at Room Temperature

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Abstract:
Because of its superior properties in shape memory effect and superelasticity by changing temperature to have a transformation between its martensitic and austenitic phases, the shape memory alloys can serve as smart materials in transducer and sensor applications. Most of Ni-Ti alloys, which are the most used shape memory alloys, are in austenite phase at room temperature, showing high strength and being hard to deform. To easily form Ni-Ti shape memory alloy sheets, they conventionally are formed and constrained in die sets at an elevated temperature, which is tool-consuming and therefore becomes a cost intensive process. To reduce the investment in capital, this study tried to use the die set only to form the Ni-Ti shape memory alloy sheets at room temperature. No further die set is used in the subsequent heat treatments. In this study, a round Ni-rich Ni-Ti shape memory alloy sheet having the thickness of 0.9 mm was heat treated at 800°C for solid solution, stretched in different strokes by a hemispherical punch having a diameter of 30 mm, and followed with an aging process at 300°C for shape memory treatment (Figure 1 top). As a result, for smaller punch strokes, such as 1 mm and 2 mm, the sheets could not be formed because the maximum strain shown in the alloy was still in the elastic region (Figure 1 bottom). After the aging process, the heights of the formed sheets were slightly shortened because of springback. However, if the sheet part was immersed in liquid nitrogen basin to have its martensitic phase and compressed into a flat shape, the original shape of the part can be fully recovered by returning to room temperature. This study also let the sheet parts undergo a constrained recovery by clamping them in a liquid nitrogen basin with a bolt-nut system sticked with strain guages to show the load reacted from the internal stress of the sheet parts during the return to room temperature.

Keywords: shape memory alloy, shape memory effect, Ni-Ti shape memory alloy, stretch forming, cold forming, free recovery, constrained recovery.

Figure 1: (top) the die, the blank holder, the punch, and the blanks used in this study. (bottom) the sheet parts stretch formed in different punch strokes.

References:

Duerig, T.W., Melton, K.N., Stoeckel, D., Wayman, C.M. (1990), *Engineering aspects of shape memory Alloys*, London: Butterworth-Heinemann Ltd.

Fann, K.-J., Huang, P.-M. (2015), Shape memory effect in aging of Ni-Ti shape memory alloy wire bent in V-shape at room temperature, *Proceedings of the Shape Memory and Superelastic Technologies Conference, SMST 2015: The Model for Shape Memory Application*, *Oxfordshire, UK.*

Titanate Nanobelts Modified by Metal Intercalation for Photovoltaic Applications

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Abstract:

One-dimensional (1-D) nanostructures (i.e., nanobelts, nanowires and nanotubes) composed of metal oxides have attracted considerable interest in applications from photocatalysis to photovoltaic conversion, because they offer advantages of accelerating electron diffusion in the long-axial direction and favoring charge carrier transfer. Doping transition metal cations into a semiconducting oxide is a viable approach to altering the chemical state and electronic structure of the host oxide so as to meet specific application requirements. In the present study, attempts have been done to introduce transition metal caions (niobium, and iron) into layered titanate nanobelts prepared by an alkaline hydrothermal process, via intercalation into the interlayer space followed by ion-exchange reaction with sodium ions. Thermal calcination was carried out for phase transformation of titanate into titanium oxide. These doped titania nanostructures were characterized for crystalline structure and element composition by X-ray diffraction and X-ray photoelectron spectroscopy and for energy band potential and photoactive trap states by electrochemical and photoluminescence analyses. The 1-D nanomaterials were evaluated as anode elements to probe their photoelectrochemical properties and photovoltaic conversion efficiencies when used in dye-sensitized solar cells. The study aimed to explore the effect of the metal doping on charge density, chemical state, optical absorption and flat-band potential. The intercalation-exchange method is promising for use to tailor functional units in two dimensional space of layered titanates as new nanomaterials.

Keywords: one-dimensional nanostructures, oxide semiconductors, metal intercalation method, photovoltaic materials, dye-sensitized solar cells.

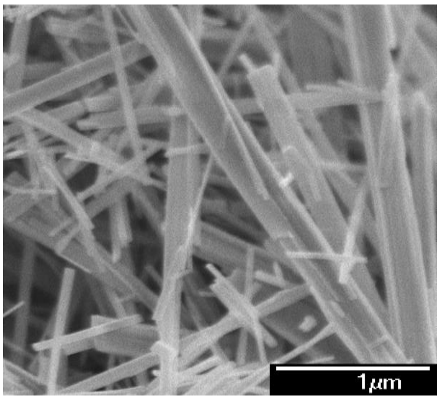

Figure 1: Field emission scanning electron microscopy of titanate nanobelts for metal intercalation, prepared by a modified hydrothermal method.

References:

1. Wang, C.-T., Chiu Y.-C., Wang W.-P. (2016) Synthesis of iron-doped titanium oxide nanobelts for dye-sensitized solar cells, Mater. Lett. 165, 189-191.
2. Wang, C.-T., Siao, H.-L. (2014) Improving photovoltaic performance of titanium oxide thin films by integration of iron doping and dye sensitization, Surf. Coat. Technol. 244, 63-68.
3. Wang, C.-T., Lai, D.-L. (2011) Synthesis and characterization of iron- and vanadium-doped titania aerogel nanopowders, J. Am. Ceram. Soc., 94(8), 2646-2651.

Graphene-Based Nano Materials Development for Thermal Insulation Applications

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Abstract:

Today there is an ever-increasing demand and awareness to save energy and lower the environmental impact in the world. The building sector is one of the areas where much effort has been devoted in this respect. There is an increasing demand for research and development of new and smart materials that may be utilized to achieve energy-efficient buildings. Thermal insulation plays a major role in controlling the energy efficiency of the buildings and thus there is considerable need to reduce the thermal conductivity below that of those currently used as conventional insulation materials such as mineral wool and polystyrene products with conductivity values around 30-40 mW/(mK). Applicable tailor-made materials like aerogels and vacuum insulation panels (VIP) also have various weaknesses like fragility, perforation vulnerability, long-time performance and relatively high costs. Hence, research groups work hard towards achieving more innovative, inexpensive and environmentally friendly solutions. Nanoscale engineering is a promising strategy for developing high performance nano insulation materials (NIM). Our aim is to attempt to develop NIM by following different paths, e.g. experimental synthesis of high purity single- or multi-layer graphene compounds mixed with renewable materials such as nano cellulose to generate more efficient thermal insulator (Wicklein et al. 2015). Initial experiments will be carried out to investigate the correlation between electrical and thermal conductivity for single and multi-layer graphene compounds and ultimately compare these results to that of graphene oxide. Another option will be mix the graphene compound with hollow silica nanospheres (HSNS) for exploration of the insulation properties.

In our earlier work, the HSNS were introduced as a promising candidate for achieving high performance superinsulation materials (SIM) for application in building constructions. However, the health, safety and environmental impact of HSNS have not yet been assessed to its full extent (Gao et al. 2013, 2014). Overall, we want to be able to foresee the properties of a new nano material that can exhibit much lower thermal conductivity for energy-efficient applications in buildings than the ones commercially available today.

Keywords: graphene, nano insulation material, NIM, hollow silica nanosphere, HSNS, thermal insulation, building.

References:

B. Wicklein, A. Kocjan, G. Salazar-Alvarez, F. Carosio, G. Camino, M. Antonietti and L. Bergström, "Thermally insulating and fire-retardant lightweight anisotropic foams based on nanocellulose and graphene oxide", *Nature Nanotechnology*, **10**, 277-283, 2015.

T. Gao, B. P. Jelle, L. I. C. Sandberg and A. Gustavsen, "Monodisperse hollow silica nanospheres for nano insulation materials: Synthesis, characterization, and life cycle assesment", *ACS Applied Materials and Interfaces*, **5**, 761-767, 2013.

T. Gao, L. I. C. Sandberg and B. P. Jelle, "Nano insulation materials: Synthesis and life cycle assessment", *Procedia CIRP*, **15**, 490-495, 2014.

Improvement in Ni (II) adsorption capacity by using Fe-nano zeolite

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Abstract

Fe-nano zeolite adsorbent was used for removal of Ni (II) ions from aqueous solution. The adsorbent was characterized by Fourier transform infrared spectroscopy (FT-IR), scanning electron microscopy (SEM) and the surface area Brunauer–Emmett–Teller (BET) using for analysis of functional groups, morphology and surface area. Bath adsorption experiments were analyzed on the effect of pH, time, adsorbent doses and initial Ni (II) concentration. The optimum pH for Ni (II) removal using Fe-nano zeolite was found at 5.0 and 90 min of reaction time. The maximum adsorption capacity of Ni (II) was 231.68 mg/g based on the Langmuir isotherm. The kinetics data for the adsorption process was fitted with the pseudo-second-order model. The desorption of Ni (II) from Ni-loaded Fe-nano zeolite was analyzed and even after 10 cycles 72 % desorption was achieved. These finding supported that Fe-nano zeolite with high adsorption capacity, high reuse ability would be utilized for Ni (II) removal from water.

Keywords: Fe-nano zeolite, adsorption, Ni (II) removal, regeneration.

Acknowledgement: This work (C0193571) was supported by the Business for Cooperative R&D between Industry, Academy, and Research Institute funded by the Korea Small and Medium Business Administration in 2015.

Enhancement of CO2 capture by using Cu-nano-zeolite synthesized

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Abstract:

In this study synthesized Cu-nano-zeolite was evaluated for its potential use in CO2 capture.
The specific surface area of Cu-nano zeolite was measured as 869.32 m2/g with the pore size of 3.86 nm. The adsorption capacity of CO2 by Cu-nano zeolite was decreased with increasing temperature. The identified adsorption capacity of CO2 by Cu-nano zeolite was 7.16 mmol/g at a temperature of 20 oC and at pressure of 1 atm. The adoption selectivity of CO2 over N2 strongly depend on the temperature and the highest selectivity by Cu-nano zeolite was 50.71 at 20 oC. From analysis of regeneration characteristics of CO2 loaded adsorbent, the percentage removal of CO2 was maintained at more than 78.2 % even after 10 cycles of adsorption-desorption. Based on these result, the Cu-nano zeolite can be used as an effective and economical adsorbent for CO2 capture.

Keywords: CO2 capture, selectivity, Cu-nano zeolite, regeneration.

Acknowledgement: This work (C0193571) was supported by the Business for Cooperative R&D between Industry, Academy, and Research Institute funded by the Korea Small and Medium Business Administration in 2015.

Facile Preparation of Hexagonal Tungsten Oxide Nanoflowers: Their Characterization and Probability of Optical and Electrochemical Detection of H_2O_2

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Abstract:

Tungsten oxide has been widely studied due to its electro-chromic and catalytic properties. Because the catalytic activities occur on the interfacial, the surface area and morphology of catalyst are closely related to their activity. Among the several structures, especially, flower-like shapes have been well known that the random branches of the nanoflowers benefit both a larger surface area and an increased substrate interaction, meanwhile, not sacrificing the good electron transportation. Tungsten oxide nanoflowers (WONFs) have been prepared through a simple hydrothermal reaction using sodium tungstate and hydrogen chloride solution at low temperature without any surfactant, capping or reducing agent. The main object of this study is to synthesize the WONFs and monitor their optical and electrochemical activities for hydrogen peroxide (H_2O_2). The WONFs were deeply characterized for various structural determinations and electrochemical analysis such as cyclic voltammetry and chronoamperometry. Peroxidase-like activities, which decomposes H_2O_2 to water molecules and electrons, of the WONFs were investigated to two ways, first is colorimetric methods, using 3,3’5,5’-tetra-methylbenzidine (TMB), with a good detection limit of H_2O_2, and second is electrochemical analysis with an excellent detection limit of 56 nM H_2O_2 using modified glassy carbon electrode (GCE). As WONFs have a large surface area, it showed the good catalytic activaties.

Keywords: Tungsten trioxide, Nanoflower, Peroxidase–like activity, Colorimetry, Electrochemical properties.

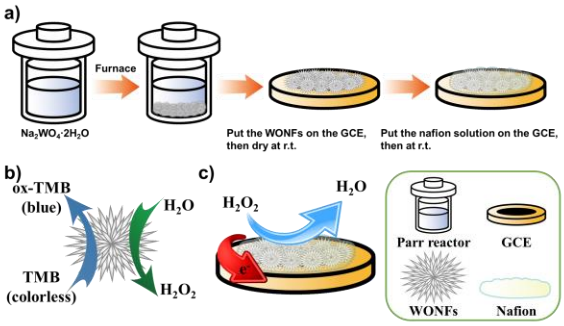

Figure 1 : (a) The preparation of WONFs and GCE modification. Mechanism for (b) optical detection of H_2O_2 using TMB and (c) electrocatalytic oxidation of H_2O_2 using WONFs-modified GCE.

References:

1. Salmaoui, S., Sediri, F., Gharbi, N., Perruchot, C., Jouini, M. (2013), Hexagonal hydrated tungsten oxide nanomaterials: Hydrothermal synthesis and electrochemical properties, *Electrochimica Acta*, 108, 634-643.
2. Xu, D. D., Jiang, T. F., Wang, D. J., Chen, L. P., Zhang, L. J., Fu, Z. W., Wang, L. L., Xie, T. F. (2014), pH-dependent assembly of tungsten oxide three-dimensional architectures and their application in photocatalysis. *Acs Applied Materials & Interfaces*, 6, 9321-9327.

Novel Donor-Acceptor Conjugated Polymers with Tunable Hues for Electrochromic Displays

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Abstract:

Donor-acceptor (D–A) type conjugated polymers have been widely explored as electrochromic materials which are able to display reversible color and transmittance changes under the influence of an external electrical bias. D–A polymers are built up of alternating electron-rich (donors) and electron-deficient (acceptors) units, which interact with each other to result in characteristic low-bandgaps and dual-band absorption profiles. Facile tuning and control of frontier molecular orbitals of the polymers can be achieved by utilizing different donor[1] or acceptor[2] moieties, as well as varying the composition ratio,[3] which consequently influences the optical bandgap, absorption behavior and perceived hue of the materials. In our work, a number of novel D–A electrochromic polymers have been synthesized, employing acceptors such as fluorinated 3-fluorothieno[3,4-b]thiophene-2-carboxylate, fluorinated 2,1,3-benzothiadiazole and diketopyrrolopyrrole. In particular, the relationship between the chemical structures and colorimetric properties is studied. All the polymers exhibit neutral hues within the visible spectrum, spanning broadly across purple, magenta, blue, blue-black, turquoise and green of the color palette. Upon electrical oxidation, the polymers reveal transmissive states. The high solution-processability of the materials enabled large-area film deposition using simple techniques like spray-casting. Such polymers also function as inks and painting techniques such as color blending and gradient effect could thus be easily carried out. Several electrochromic display prototypes have been successfully developed and demonstrated, paving the way towards an advanced, new-generation, energy-saving color-changing technology.

Keywords: electrochromic, donor-acceptor, conjugated polymers, color palette, electronic displays.

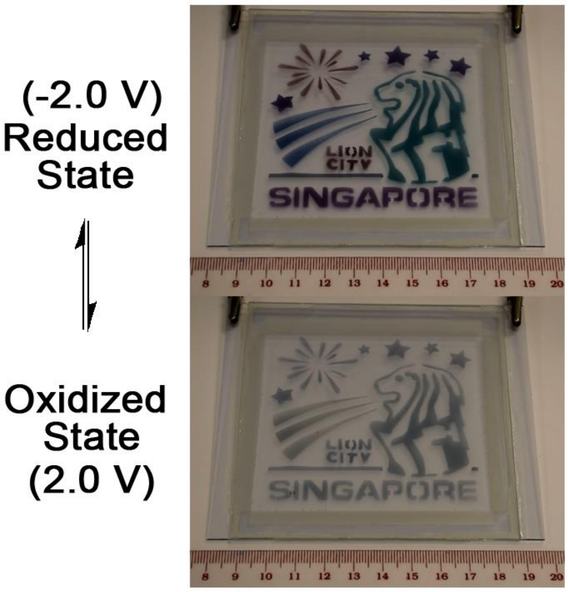

Figure 1: Electrochromic display prototype exhibiting reversible switching between dark, colored (reduced) and light, transmissive states (oxidized).

References:

1. Shi, Z.; Neo, W. T.; Lin, T. T.; Zhou, H.; Xu, J. (2015) Solution-processable low-bandgap 3-fluorothieno[3,4-b]thiophene-2-carboxylate-based conjugated polymers for electrochromic applications, *RSC Advances*, 5 (117), 96328-96335.
2. Neo, W. T.; Ong, K. H.; Lin, T. T.; Chua, S.-J.; Xu, J. (2015) Effects of fluorination on the electrochromic performance of benzothiadiazole-based donor-acceptor copolymers, *Journal of Materials Chemistry C*, 3 (21), 5589-5597.
3. Neo, W. T.; Shi, Z.; Cho, C. M.; Chua, S.-J.; Xu, J. (2015) Effects of Chemical Composition, Film Thickness, and Morphology on the Electrochromic Properties of Donor–Acceptor Conjugated Copolymers Based on Diketopyrrolopyrrole, *ChemPlusChem*, 80 (8), 1298-1305.

Frequency Study of the Polymer Coated SAW Micro-sensor to the Chemical Agent Simulant

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Abstract:
For the last decade, MEMS and nano technology accelerated extreme miniaturization technology in the use of various sensor devices, In particular many of chemical and biological detectors are becoming in a micro size using MEMS and nano technology. Currently most of the extreme miniaturized sensor device being developed can be classified into three types, commonly referred to a "Micro sensor" using MEMS technology, a "smart dust" using microelectronics and a "wearable sensors" designed to be able to combine human clothing or accessories. These 3 types of sensors has its respective advantages. First of all, power consumption is extremely low, therefore it is possible to lengthen the operating time of the sensors, so very useful in the use of future soldier system, UAV and insect-type detectors. Most of the current chemical/biological detector being used in armed forces are too bulky and heavy. Therefore there are a number of limitations for military soldiers to operate under future NBC warfare environment. However these 3 types of extreme miniaturized sensors have excellent potential in the future micro-sensors. In this paper, we described for the SAW micro-sensor which is expected to be useful chemical detection micro-sensors. SAW sensor and its actuation circuit was designed in our lab. After that, spin coated on its each surface with synthesized polyvinylidene fluoride(PVDF) and norbornene. Evaluated its sensitivity each SAW device to the chemical simulant DMMP as a fuction of different concentration. Frequency variation appeared a fairly good results, The linearty was showed good proportional to the vapor concentration of DMMP, The results was effective in the range of sub ppm level, and the lowest detected concentration, up to several tens of ppb. Therefore, it showed the SAW sensor have potential as a chemical sensor in the future.

Keywords: chemical/biological detector, micro-sensor, MEMS, nano, sensitivity, DMMP

SnO_2-ZnO-CuO multilayerd sensor structure for H_2S detecting

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Abstract: H_2S gas resulting from mines and refineries has detrimental impact on human health and industries. According to this fact, the present study was conducted with the aim of detecting H_2S gas using thin layers of CuO and ZnO on ITO which contains SnO_2 nanoparticles (multilayer SnO_2-ZnO-CuO). Due to ease of use, proper distribution of particles, etc., the hydrothermal method was proposed in the present research in order to synthesize CuO and ZnO nanoparticles. CuO was coated on ITO substrate using spin-coater. Moreover, Scanning Electron Microscope (SEM) and Energy Dispersive X-ray Microanalysis (EDX) were employed in order to investigate morphology and structure. In order to understand the sensory properties, the gas test, which is based on changes resistance, was designed at room temperature. Afterwards, sensory properties were proved by drawing resistance curve. The best value for response was equal to 1070, the best response time was 30 seconds and the minimum recovery time was 183 seconds. The values related to response time and recovery time were improved in the sample containing ZnO.

Keywords: Nanostructure sensor, Thin layer, H_2SGas sensor, H2S, SnO2-ZnO-CuO, Hydrothermal

References:

1. Sulfide scavengers in Oil and Gas industry- A review. NAFTA. M.K. Amosa, I.A.M., S.A. Yaro. 2010, pp. 85-92.
2. Arijit Chowdhuri, a.P.S., Vinay Gupta, K. Sreenivas, K. V. Rao, H2S gas sensing mechanism of SnO2 films with ultrathin CuO dotted islands. APPLED PHUSICS, 2002. 92(4): p. 2172-2180
3. Delgado RD. Tin oxide gas sensors: an electrochemical approach. Spain: Universitat Autònoma de Barcelona; 1998.
4. A. Ebrahimi, A. Pirouz, Y. Abdi, S. Azimi, S. Mohajerzadeh , Selective deposition of CuO/SnO2 sol–gel on porous SiO2 suitable for the fabrication of MEMS-based H2S sensors. Sensors and Actuators B.2012;173.p:802-810
5. Verma MK, Gupta V. A highly sensitive SnO2–CuO multilayered sensor structure for detection of H2S gas. Sensors and Actuators B: Chemical. 2012;166-167.p:378-85.
6. J. Tamaki, T. Maekawa, N. Miura, N. Yamazoe, CuO–SnO2 element forhighly sensitive and selective detection of H2S, Sensors and Actuators B 9(1992) 197–203
7. Qiaobao Zhang, Kaili Zhang , , Daguo Xu , Guangcheng Yang , Hui Huang ,. CuO-nanostructures-Synthesis,-characterization,-growth-mechanisms,-fundamental-properties,-and-applications.Progress-in-Materials-Science : s.n., 2014
8. S. Sujatha Lekshmy, Georgi P. Daniel, K. Joy ,Microstructure and physical properties of sol gel derived SnO2:Sb thinfilms for optoelectronic applications, Applied Surface Science,2013.274.p:95-100
9. Yeo-Chang Yoon, Kyoung-Seok Park, Sam-Dong Kim,Effects of low preheating temperature for ZnO seed layer deposited bysol–gel spin coating on the structural properties of hydrothermal ZnO nanorods, Thin Solid Films,2015.597.p:125-130
10. M.S Wagha, L.A Patila, , , Tanay Sethb, D.P Amalnerkarb Surface cupricated SnO2–ZnO thick films as a H2S gas sensor. Materials Chemistry and Physics.2004.84(2-3).p:228-233
11. S. Santra, P. K. Guha, S. Z. Ali, P. Hiralal,H. E. Unalan, J. A. Covington, G. A. J.Amaratunga, W. I. Milne, J. W. Gardner, andF. Udrea ZnO nanowires grown on SOICMOS substrate for ethanol sensing, Sensors and Actuators B: Chemical, 2010. 146, p:559-565,
12. E. Oh, H.-Y.Choi, S.-H. Jung, S. Cho, J. C.Kim, K.-H. Lee, S.-W. Kang, J. Kim, J.-Y.Yun, and S.-H. Jeong, High-performanceNO2 gas sensor based on ZnO nanorod grownby ultrasonic irradiation, Sensors and Actuators B: Chemical, 2009. 141,p: 239-243,
13. J. Xu, J. Han, Y. Zhang, Y. a.Sun, and B.Xie, Studies on alcohol sensing mechanism of ZnO based gas sensors, Sensors and Actuators B: Chemical, 2008. 132, p:334-339,
14. A. Chowdhuri, S.K. Singh, K. Sreenivas, V. Gupta, Contribution of adsorbedoxygen and interfacial space charge for enhanced response of SnO2 sensors having CuO catalyst for H2S gas, Sens. Actuators B.2010.145.p: 155–166

Proton Beam Writing (PBW) of Polymeric Micro-cantilever based RF-MEMS switch

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Abstract

The proton beam writing (PBW) technique was used to fabricate overhanging structures for microelectromechanical actuator applications. The structures were fabricated in a conductive polymeric composite contains SU-8 resist and silver nanoparticles (SU-8/AgNps). Overhanging structure or multilevel structure was fabricated as part of a project to develop functional polymeric MEMS actuator device for RF-MEMS switch. Protons with energies between 2.5 MeV and 0.75 MeV were used to fabricate the RF MEMS switch with a minimum feature size of around 1 um and depths of 30 to 60 μm. Silver nanoparticles ranged from about 20 to 100 nm. Mechanical and electrical properties of the fabricated structure were investigated at range of proton beam doses (5 to 50 nC/mm^2). Exposure regime and examples of functional MEMS actuator fabricated using PBW are described. COMSOL Multiphysics software was used to model the actuation process and investigating some RF-MEMS switch parameters such as switching time, capacitance ratio of the MEMS actuator based on the measured electrical and mechanical properties.

Keyword: Proton beam writing , conductive polymer, Microfabrication

MEMS

Novel Pyrrolophthalazine dione-Based Conjugated Polymers for Electrochromic Applications

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Abstract:

Electrochromic materials have been demonstrated as a new generation smart materials which can be applied in smart windows, displays and many other attractive chromic applications. Donor-acceptor type conjugated polymers have been witnessed as a promising materials for electrochromic applications due to their facile physical properties tuning, good processability and good electrochromic properties. In this study, we synthesized a new electron acceptor building block, i.e., pyrrolophthalazine dione, and applied it in a series of donor-acceptor type conjugated polymers with low band gaps for electrochromic applications. The obtained polymers exhibited good solvent processability and reversible color switching during operation from dark blue at neutral state and light cyan at oxidized state. The obtained polymer materials have been demonstrated as high performance electrochromic materials and have the potential to be applied for smart windows and electrochromic display applications.

Keywords: electrochromic, donor-acceptor, conjugated polymer, smart window

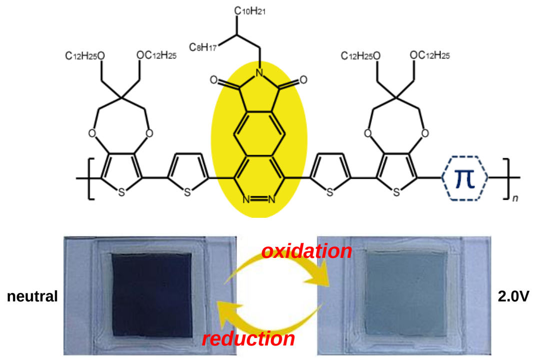

Figure 1: Top: The chemical structures of imide-fused phthalazine based conjugated polymers. Bottom: The color switching of the polymers between neutral state and oxidized state at 2.0 V.

References:

E. E. Havinga, W. ten Hoeve, H. Wynberg, *Polymer Bulletin*, **1992**, *29*, 119.

Qun Ye, Ching Mui Cho, Wei Teng Neo, Jianwei Xu, Singapore patent, 2014.

Qun Ye, Wei Teng Neo, Tingting Lin, Jing Song, Hong Yan, Hui Zhou, Kwok Wei Shah, Soo Jin Chua, Jianwei Xu, *Polym. Chem.* **2015**, *6*, 1487-1494.

Synthesis of Ultrahighly Electron-Deficient Pyrrolo[3,4-d]pyridazine-5,7-dione by Inverse Electron Demand Diels–Alder Reaction and Its Application as Electrochromic Materials

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Abstract:

Electrochromic materials are a new type of smart materials that have various useful applications in the materials industry. Through the search of new molecules that have electrochromic properties, an interesting synthesis has been discovered that give raise to a new electron acceptor 6-alkylpyrrolo[3,4-d]pyridazine-5,7-dione (PPD). It has a low LUMO level and is synthesized using an inverse electron demand Diels-Alder reaction between thiophene- or furan- decorated tetrazine substrates with an electron-deficient 1-alkyl-1H-pyrrole-2,5-dione unit. The resulting electrochromic materials from the incorporation of the PPD monomer into a series of donor-acceptor-type conjugated polymers have shown good optical contrast, switching speed and coloration efficiency.

Keywords: Electrochromic, smart material, conjugated polymer, donor acceptor

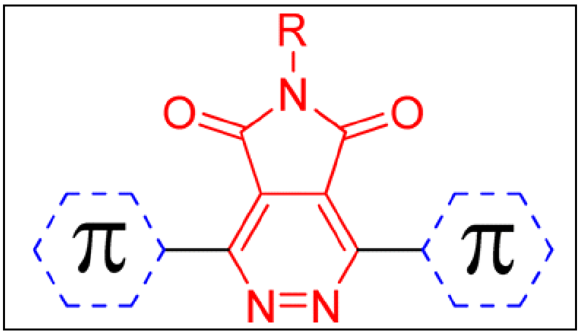

Figure 1: Figure that shows the PPD monomer with different π-conjugated substituents.

References:

Qun Ye, Wei Teng Neo, Ching Mui Cho, Shuo Wang Yang, Tingting Lin, Hui Zhou, Hong Yan, Xuehong Lu, Chunyan Chi, and Jianwei Xu, Organic Letters 2014 16 (24), 6386-6389

Qun Ye, Wei Teng Neo, Tingting Lin, Jing Song, Hong Yan, Hui Zhou, Kwok Wei Shah, Soo Jin Chua and Jianwei Xu, Polym. Chem., 2015, 6, 1487-1494

TiO_2 Nanorod thin films embedded with Gold nanoparticles for enhanced photocatalytic activity

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Abstract:
TiO_2 as a photocatalyst have attracted a major a interest due to its high activity, low toxicity, chemical stability, low pollution load, robustness against photocorrosion and availability at low cost. Metals with free electrons possess Plasmon resonance in the visible spectrum that gives rise to intense and attractive colourations. Gold nanoparticles are often selected as a cluster to reach the surface Plasmon resonance effect on TiO_2 dielectric matrices. Gold/ TiO_2 nanocomposites have also attracted a great deal of attention for their applications in solar energy [Wu X et al. 2015]. Metal Au nanoparticles can absorb light efficiently compared to semiconductors and dyes. By modifying TiO_2 films with small Au NPs, the photocatalytic activity of TiO_2 is increased [Jung J M et al.2008]. In recent years, Au doped TiO_2 have been investigated to enhance the photocatalytic efficiency of TiO_2 in decomposing organic compounds and photokilling bacteria [Chen Z-Y et al 2009.]. TiO_2 thin film with vertically aligned nanorod were prepared by hydrothermal method and gold nanoparticles were embedded into the interstitial holes of the nanorod TiO_2 films. The surface treatments of consumer goods have a high interest because of their wide possibility for application in different industrial Sectors [Torrell M et al. 2010]. The samples with gold nanoparticles have much higher photocatalytic efficiency than that without gold nanoparticles under visible light irradiation [Fu P et al. 2011]. The modification of gold on the surface of TiO_2 nanoparticles greatly enhanced the photocatalytic activation effect of TiO_2 nanorod films.

Keywords: TiO_2, Au, Photocatalyst, Solar cells.

References:

[1] Wu X, Centeno A, Zhang X, Darvill D, Ryan M P, Riley D J, Alford N M and Xie F 2015 Broadband plasmon photocurrent generation from Au nanoparticles/ mesoporous TiO2 nanotube electrodes *Solar Energy Materials and Solar Cells* **138** 80–5.

[2] Jung J M, Wang M, Kim E J, Park C and Hahn S H 2008 Enhanced photocatalytic activity of Au-buffered TiO2 thin films prepared by radio frequency magnetron sputtering *Applied Catalysis B: Environmental* 84 389–92.

[3] Chen Z-Y, Hu Y, Liu T-C, Huang C-L and Jeng T-S 2009 Mesoporous TiO2 thin films embedded with Au nanoparticles for the enhancement of the photocatalytic properties *Thin Solid Films* 517 4998–5000.

[4] Torrell M, Cunha L, Cavaleiro A, Alves E, Barradas N P and Vaz F 2010 Functional and optical properties of Au:TiO2 nanocomposite films: The influence of thermal annealing *Applied Surface Science* 256 6536–42.

[5] Fu P and Zhang P 2011 Enhanced photoelectrochemical properties and photocatalytic activity of porous TiO2 films with highly dispersed small Au nanoparticles *Thin Solid Films* 519 3480–6.

Fabrication, Characterization and Gas Sensing of Cobalt Antimony Oxide Nanospheres Prepared via Sol-Gel Method

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Abstract:

The development of gas sensor is imperative due to the alarm for safety requirements in homes and industry, especially liquefied petroleum gas (LPG), which is one of the extensively used but potentially hazardous gases (Singh *et al*.; 2014, 2015). Thus the requirement for reliable and sensitive gas detecting instruments has increased for safety. In this work, we have synthesized antimony based trirutile oxide for the investigation of the sensing performance. Antimony based nanostructured materials are promising due to the fact that antimony acts as a catalysis and increases the rate of reaction (adsorption/desorption) between the target gas molecules and the sensing surface. This may play a significant role to improve the sensitivity, selectivity, repeatability, stability, and response and recovery times of the sensor.

Cobalt antimony oxide nanospheres (NS) have been fabricated by sol-gel spin coating process. The process used here is convenient, environmental friendly, inexpensive and efficient for the preparation. The prepared nanospheres have been characterized by utilizing X-ray diffraction (XRD), scanning electron microscopy (SEM) and fourier transforms infrared spectroscopic (FT-IR) techniques which reveals that the synthesized cobalt antimony oxide ($CoSb_2O_6$) is well crystalline having crystallite size 27 nm. UV-visible absorption was used to investigate the optical properties of $CoSb_2O_6$ nanospheres. The increment in the band gap of $CoSb_2O_6$ establishes the quantum confinement effect. The gas sensing behavior of the fabricated film was analyzed at room temperature by measuring the changes in electrical resistance of the sensor material in the presence of reducing (liquefied petroleum gas- LPG) as well as oxidizing (carbon dioxide- CO_2) gases as a function of gas concentration and response time. Larger variations in electrical resistance were observed for LPG in comparison to CO_2 gas. The LPG sensor possesses high sensitivity and repeatability, as well as, fast response and recovery times. As a result nanostructured $CoSb_2O_6$ may be considered as a potential sensing material for the fabrication of highly sensitive LPG sensor operable at room temperature. Antimony acts as a catalyst for the dissociation of oxygen over the film surface, and thus, enhances the spillover of oxygen species over the film surface which may enhance the sensitivity of the sensor. The increased reactivity of the nanostructured oxide materials at room temperature may result in an increase in the sensitivity, with a decrease of required power consumption and a beneficial effect on sensor stability and lifetime.

Keywords: $CoSb_2O_6$, nanospheres, gas sensor, response and recovery times, sensitivity, sensor .

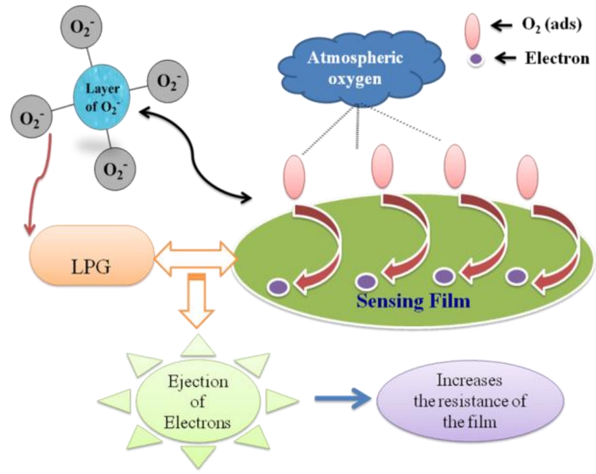

Figure 1: Figure illustrating the schematic of the sensing reactions at the surface of the film.

References:

Singh, A., Singh, A., Singh, S., Yadav, B.C., Tandon, P. (2015), Synthesis, characterization and performance of zinc ferrite nanorods for room temperature sensing applications, *J. Alloys Comp.*, 618, 475-483.

Singh, S., Verma, N., Singh, A., Yadav, B.C. (2014), Synthesis and characterization of CuO-SnO_2 nanocomposite and its application as liquefied petroleum gas sensor, *Mater. Sci. Semi. Process.*, 18, 88-96.

Fabrication of Heterostructure of 3-D Photonic Crystals of Polystyrene Microspheres by Self-Assembly Routes

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Abstract:

The monodispersed, narrowly size-distributed polystyrene (PS) microspheres of various diameters were produced by both dispersion polymerization process and emulsifier-free polymerization processes. Subsequently the photonic crystals (PhCs) of PS microspheres upon the ITO glasses and ITO/PET flexible substrates were perfectly formed via electrophoretic self-assembly (EPSA) route and isothermal heating evaporation-induced self-assembly(IHEISA) method. Moreover a swift combination of EPSA and IHEISA technique were employed to fabricate the heterostructure (HS) of PhCs, of which the optical properties were characterized accordingly. The results indicated that the HS of 3-D PhCs templates with two different sizes of PS microspheres, which has multi-photonic band gaps, were fabricated via EPSA and IHEISA technique. The goal of this study is to offer a handy way for developing advanced optical functionalities with enhancement of PBG efficiency.

Keywords: dispersion polymerization, emulsifier-free polymerization, photonic crystals (PhCs), electrophoretic self-assembly(EPSA), heterostructure, polystyrene (PS) microspheres.

Influence of eplating formulations on microstructure and corrosion resistance of electrodeposited zinc coatings

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Abstract:

While zinc coatings of various plating baths' formulations are being employed widely in various applications including automotive and electronic parts, a systematic study that aims to comparatively analyze their microsturucture and corresponding corrosion resistance is very limited. In the present work, the microstructure and corrosion resistance of electrodeposited zinc coatings prepared from acidic, alkaline and cyanide baths with various plating durations were critically investigated. The microstructure and surface morphology of the specimens were examined using x-ray diffractometry and scanning electron microscopy. The corrosion resistance of the specimens was determined by electrochemical impedance spectroscopy (EIS), potentiodynamic polarization, and ASTM B117 salt spray testing. The results indicated that the plating formulations largely controlled crystallographic structure, microstructure, and hence corrosion behaviors of the deposits. Particularly, zinc coatings from the alkaline bath were characterized by distict crystallographic texture, relatively large crystallite size, high and moderate corrosion resistance according to EIS and salt spray test, respectively. The relationships between microstructure and corrosion properties of the zinc coatings are addressed and discussed in the study. The results of the work would enhance the understanding of how the deposits' microstructure influences the properties, and help the industry choose suitable plating formulations for zinc electrodeposits in their applications.

Keywords: electrodeposition; microstructure; corrosion; zinc.

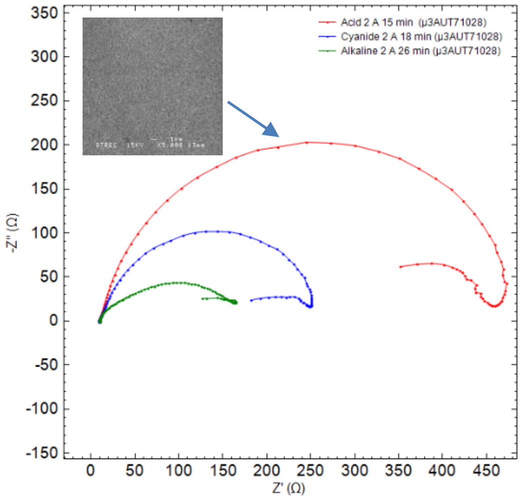

Figure 1: EIS Nyquist diagrams of electroplated zinc coatings prepared from acidic (with an SEM image 5,000x), cyanide and alkaline baths.

References:

Hsieh J.C., Hu C.C., Lee T.C. Effects of polyamines on the deposition behavior and morphology of zinc electroplated at high-current densities in alkaline cyanide-free baths, *Surface & Coatings Technology*, 203, 3111-3115.

Khorsan S., Raeissi K., Golozar M.A. (2011) An investigation on the role of texture and surface morphology in the corrosion resistance of zinc electrodeposits, *Corrosion Science*, 53, 2676-2678.

Silver Nanoparticles Inkjet Printing on Polyurethane Nanofiber for Water Purification Application

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Abstract:
Microbiological contamination of drinking water is a global concern. To solve this issue, we describe a new approach of antibacterial water-filter generation which utilized inkjet printing to deposit silver nanoparticles onto an electrospun polyurethane fibrous membrane. It was found that the polyurethane fiber was uniformly fabricated and silver nanoparticles were evenly deposited onto the fibrous strands. Additionally, silver nanoparticles were printed on the membrane using inkjet printing. Our developed silver-nanoparticle modified polyurethane fibrous membrane showed significant inhibition against four kinds of pathogens that lead to fatal water borne diseases. These results indicate that our approach, which allows for simple, low-cost, mass production of filters, may be useful in the field of water environmental science as a means to generate water purification membranes and filters.

Keywords: silver nanoparticle, inkjet printing, water purification, antimicrobial membrane

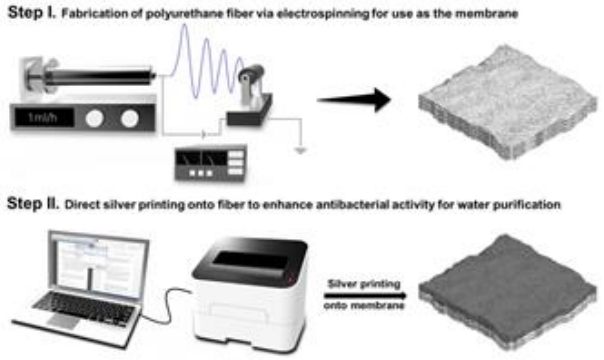

Figure 1: Schematic illustration of the preparation of antibacterial membrane for water purification

References:
Sang Jin, L., Dong Nyoung, H., Ji-Hoi, M., Wan-Kyu, K., Jung Bok, L., Min Soo, B., Se Woong, P., Ji Eun, K., Dong Hyun, L., Eun-Cheol, K., Chang Hoon, L., Il Keun, K., (2014) Electrospun chitosan nanofibers with controlled levels of silver nanoparticles. Preparation, characterization and antibacterial activity, *Carbohyd. Polym.*, 111, 530-537

Thi Thi, N., Masaya, N., Katsuaki, S., Electrical functionality of inkjet-printed silvernanoparticle conductive tracks on nanostructured papercompared with those on plastic substrates, (2013) *J. Mater. Chem. C*, 1, 5235

Development of CT/NIRF Dual Imaging Probe to Detect Thrombosis

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Abstract: Gold nanoparticle (AuNP) is one of the inorganic materials being studied in various biomedical researches due to its several advantageous properties such as low cytotoxicity and controllable surface functionality or morphology with well-established methods. In the point of biomedical imaging, AuNPs have outstanding x-ray attenuation property due to its high electron density and shows effective fluorescent-quenching effect by fluorescence resonance energy transfer (FRET). These characteristics of AuNPs make it possible to be applied in multi-modal contrast agent. In this study, we developed thrombin activating CT/NIRF dual-imaging probe which can detect thrombosis in the blood stream. AuNPs were coated with silica, providing biocompatibility and surface functionality. Then a specific peptide which is selectively cleaved by thrombin was conjugated fluorescent dye for NIRF imaging (Thr-dye), and this peptide was immobilized onto surface of the nanoparticle. Synthesized nanoparticle-based multifuntional probe is expected to be applied in CT/NIRF dual imaging. At normal state, nanoparticle conjugated NIRF dye is quenched because of the nanoparticle surface energy transfer (NSET) between AuNPs and dye. When near thrombosis protease reaction by thrombin is introduced to NIRF dye, the detection of thrombosis could be possible. Finally, CT/NIRF dual imaging probe based on AuNPs and dye was prepared to show promising results for detecting thrombosis.

Acrylate copolymers containing urushiol as the active compound for antibacterial and antifouling application.

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Abstract:
Urushiol ia an excellent varnishing material. we utilized it for the preparation of acrylate tri-copolymers using the monomers 2-Hydroxyethylacrylate (HEA) and 2- methoxyethylacrylate (MEA), methyl methacrylate (MMA), and acrylic acid (AA). A minimum weight percentage of urushiol has been used (5 and 10 wt. % of combined weight of the other two monmers in the tripolymer). Two different forms of urushiol are used; pure urushiol (U) and esterfied adduct of urushiol with Hydroxyethylacrylate (U-HEA). Aim is the application as antifouling and antimicrobial protective coatings and assessment of the microbial activity of the catechol ring and the alkyl side chain of urushiol. Conventional free radical polymerization is used for the preparation of tripolymers, with AIBN as radical initiator. The spin casted polymers on slide glass were studied for the antimicrobial activity against Staphylococcus aureus (MRSA). The polymers demonstrate an excellent antibacterial assessment, visualized by Confocal Lazer Scaaning Microscopy (CLSM). The spectroscopic techniques employed for analyzing the polymers are FT-IR, ^{1}H NMR, TGA, and GPC.

Keywords: urushiol, acrylates, tripolymers, antimicrobal, antifouling, free radical polymerization, spin cast.

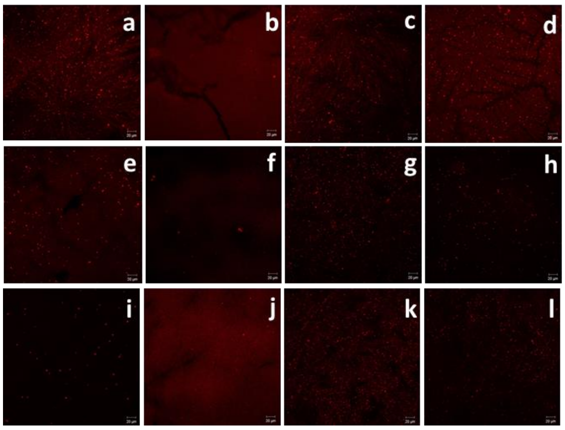

Figure 1: Confocal lazer scanning microscopic images of various polymer compositions: a, b, c, d represent the antibacterial effect of homopolymers PHEA, PMEA, PMMA, and PAA, respectively. Images e, f, g, and h show the antibacterial effect of p(HEA-U-MEA), p(HEA-U-MMA), p(HEA-U-AA), and p(MEA-U-AA), respectively, containing 5 wt. % of U. And i, j, k, and l represent the effect of p(HEA-UHEA-MEA), p(HEA-UHEA-MMA), p(HEA-UHEA-AA), and p(MEA-UHEA-AA), respectively, containing 5 wt. % of UHEA.

Core-shell structured upconversion luminescent nanocomposites conjugated with graphene oxide quantum dots for photodynamic therapy

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Abstract:
The common cancer among women the breast cancer, and the anxiety about this disease has triggered a research for advancement in tumor prognosis and therapy. Thus, multifunctional nanocomposite can act as imaging probe, drug delivery, and therapeutic effect itself were proposed to improve the treatment efficiency and reduce the side effects. In this study, the core-shell structured upconversion nanoparticles (UCNPs) and graphene oxide quantum dots (GOQD) were conjugated using bifunctional amine polyethylene glycol (NH_2-PEG). In addition, hypocrellin A (HA) as a photo-sensitizer (PS) was loaded on the surface of GOQD. The UCNP has attracted a great attention and applied widely from the biotechnology to high chemical stability due to its low toxicity and biocompatibility. Moreover, cell images for verificating apoptosis/necrosis of cancer cells using the UC luminescent techniques have been performed. Graphene oxide has been widely studied as promising drug delivery vehicles to improve tumor therapic effect. GOQD was conjugated with HA by π-π interaction and subsequently utilized to load the anti-tumor effect. In order to show the enhancement of photo-dynamic therapy (PDT), it was verified with free HA and UCNP-GQD induced HA. As a result, it was revealed that the result has noticeably enhanced anti-tumor ability because of photodynamic tumor cell death based on the nanocomposites. Therefore, the UCNP-GOQD/HA nanocomposites would be excellent candidates as multifunctional agents of UCL imaging and PDT for tumor.

Keywords: upconversion nanoparticle, Graphene oxide quantum dot, hypocrellin A, photo dynamic therapy

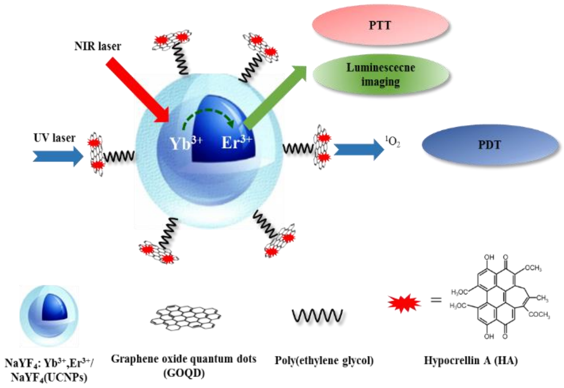

Figure 1: Schematic illustration of UCNP-GOQD/HA as a multifunctional theranostic nanoplatform for cancer treatment.

References:

1. Zhou, L., Ge, X., Zhou, J., Wei, S., & Shen, J. (2015). Multicolor imaging and the anticancer effect of a bifunctional silica nanosystem based on the complex of graphene quantum dots and hypocrellin A. *Chemical Communications*, *51*(2), 421-424.
2. Yao, J., Yang, M., & Duan, Y. (2014). Chemistry, biology, and medicine of fluorescent nanomaterials and related systems: New insights into biosensing, bioimaging, genomics, diagnostics, and therapy. *Chemical Reviews*, *114*(12), 6130-6178.

Nanographene-Coated Double Nanoemulsion for Image-Monitored Controlled Drug Delivery

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Abstract:

Current efforts in the area of ocular drug delivery for glaucoma treatment include frequent intravitreal injection or surgical implants, which is not only invasive and inconvenient for patients but also may increase the risk of complications (Zhou et al. 2013). Therefore, development of stable drug delivery systems which have ability to be released in a controlled manner for a long-term is necessary. Nanographene, nano-sized graphene, has attracted great interests in various fields including biomedicine because of the unique intrinsic physical properties and their small size (Yang et al. 2015). In this study, we demonstrate stable drug delivery systems which release drug upon external activation energy by utilizing nanographene's high near-infrared (NIR) light absorbing properties.

We develop nanographene-coated phase-transition double nanoparticles which encapsulate drug molecules for an image-monitored controlled-release ocular drug delivery system. Drug inside the particle core is released upon near-infrared laser application, which induces heat generation in the nanographene and phase-transition of the nanoparticles to gas microbubbles. Nanographene was created by probe sonication method and the average size measured by dynamic light scattering was 200 nm (**Figure 1**). Nanographene coats the nanoparticles via electrostatic self-assembly. The double nanoparticles is stable against aggregation, disruption, and passive drug leakage from the core in physiological conditions. The phase-transitioned gas bubbles are acoustically active under ultrasound waves, which enhances ultrasound imaging contrast. While the droplets were phase-transitioning, ultrasound images (B-mode) were acquired to confirm the phase-transition (**Figure 2**). These bubbles are bright under ultrasound imaging because of materials impedance difference between surrounding water and gas. Therefore, the system allows controlled-release drug delivery for a long-term (months) upon external trigger, while monitoring quantitative evaluation of drug delivery with ultrasound imaging.

Keywords: graphene, drug delivery, biomedical applications.

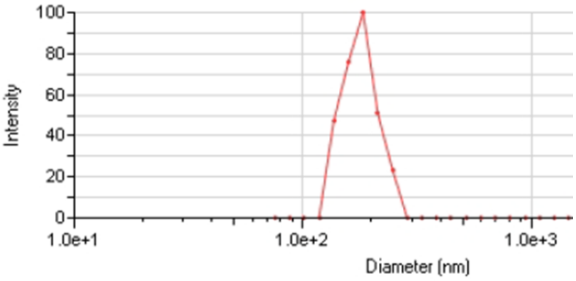

Figure 1: The average diameter of nanogrphene is 200 nm, measured by dynamic light scattering.

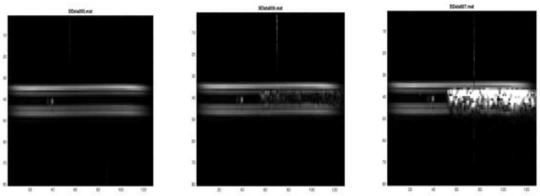

Figure 2: Ultrasound images of phase transition. Bright area demonstrates microbubbles phase-transitioned from the double nanoparticles.

References:

Zhou, H. Y., Hao, J. L., Wang, S., Zheng, Y., Zhang, W. S. (2013) Nanoparticles in the ocular drug delivery. *Int J Ophthalmol-Chi* 6, 390-396.

Yang, K., Feng L., Liu, Z. (2015) The advancing uses of nano-graphene in drug delivery, *Expert Opin. Drug Deliv.* 12 (4), 601-612.

Direct synthesis of vertically standing graphene film on various substrates by electron cyclotron resonance plasma

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[2]Plasma technology research center, Osikdo-dong 814-2, Gunsan-si, Jeollabuk-do, Korea
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Abstract:

Vertically standing multi-layer graphene films (VMGs) were synthesized by electron cyclone resonance microwave plasma on various substrates at low temperature.

To synthesize VMS films, H_2 gas was injected into process chamber as carrier gas aiming to anneal the substrate and provide active defects, which promotes graphene nucleation formation, on surface. Reactive CH_4 gas was then infused into processing chamber during discharging H_2 plasma. The ratio of H_2 carrier gas flux to CH_4 gas, reactive carbon species source, was regulated by mass flow controller.

Characteristics of VMG films on various substrates, including copper film, glass slide, and silicon wafer were analyzed in terms of structural, electrical and optical properties.

The active carbon species participating in the graphene synthesis were observed by residual gas analyzer (RGA).

The morphologies and microstructures of multilayer graphene were characterized using field emission scattering electron microscope, high resolution transmission electron microscope, and Raman spectra measurement.

The VMGs on different substrates at the same experimental conditions synthesized the wrinkled VMGs with different heights. In addition, the transmittance and electrical resistance were measured using ultra-violet visible near-infrared spectroscopy and 4 probe point surface resistance measurement.

The results presented herein demonstrate a simple method of synthesizing of VMGs on various substrates at low temperature for mass production, in which the VMGs can be used in a wide range of application fields for energy storage, catalysis, and field emission due to their unique orientation.

Keywords: graphene, nano-wall, vertical graphene, microwave plasma, electron cyclotron resonance

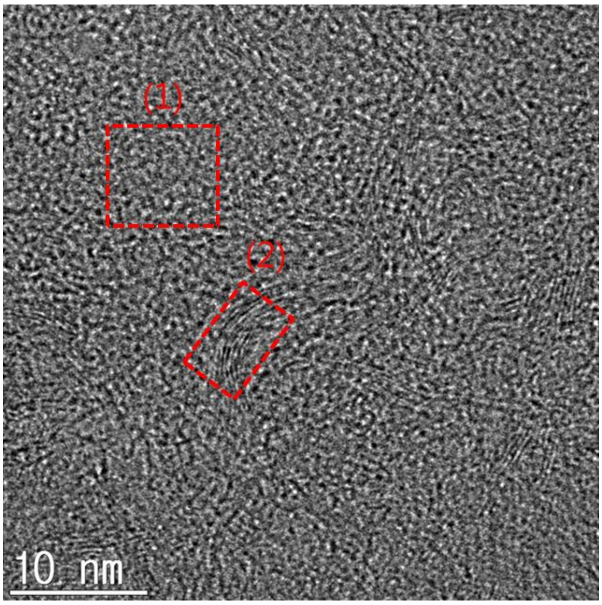

Figure 1: TEM image of graphene nona-wall on Cu substrate synthesized by electron cyclotron resonance plasma. (1) amorphous carbon underlying few-layer graphene nano-wall(2)

References:

Xiuyun Zhang, Lu Wang, John Xin, Boris I., Yakobson, and Feng Ding (2014), Role of hydrogen in graphene chemical vapor deposition growth on a copper surface, J. Am. Chem. Soc., 136, 3040−3047.

Yihong Wu (2002), Effects of Localized Electric Field on the Growth of Carbon Nanowalls, Nano Lett., 2, 355-359.

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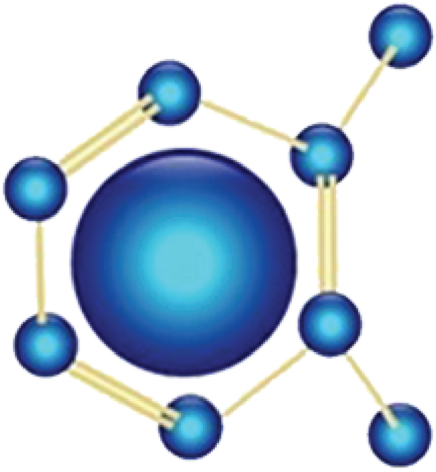

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