

To spread information and knowledge and to promote collaboration in the area of Materials Research, Engineering and Technology amongst the members of MRS-S

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➤ MRS-S Activities: Past, Present and Future

The Materials Research Society of Singapore (MRS-S) organized four International and three National Conferences in Singapore since 2001. The biennial 'International Conference on Materials for Advanced Technologies (ICMAT)' series were held in 2001, 2003, 2005 and 2007. The biennial National Conferences were held in 2004, 2006 and 2008. MRS-S also sponsored/supported several other conferences, workshops, symposia and public lectures. It instituted gold medals for the best outgoing students in Materials Science at the National University of Singapore (NUS) and Nanyang Technological University (NTU). It instituted the 'MRS Singapore Student Bursary Fund' at the National University of Singapore. MRS-S also instituted the 'MRS-S Book Prize' at the 'Republic Polytechnic' of Singapore. This yearly Book Prize will be awarded to the top final-year student from the 'Diploma in Materials Science'.

To reach out to the public, MRS-S has organized number of public lectures by Nobel Laureates and also an Astronaut.

ICMAT 2009 & IUMRS-ICA 2009 will be held during June 28-July 3, 2009 in Singapore. It will have 23 Symposia, 9 Plenary and 3 Theme Lectures in addition to the Keynote, Invited, Oral talks and Poster presentations. There will also be an Exhibition of the products and services by the manufacturers, book and journal publishers.

The second and final Announcement of ICMAT 2009 & IUMRS-ICA 2009 is available at the website: www.mrs.org.sg

➤ Highlights of previous ICMAT Conferences

Year 2001: 1-6, July 2001; 16 Symposia; 10 Plenary Lectures; 4 Public Lectures by Nobel Laureates; 1400 delegates; 18 Best Poster Awards; 36 Exhibitors.

Year 2003: 7-12, Dec., 2003; 16 Symposia; 9 Plenary Lectures; 2 Public Lectures by Nobel Laureates; 1500 delegates; 19 Best Poster Awards; 29 Exhibitors.

Year 2005: 3-8, July 2005; 25 Symposia; 9 Plenary Lectures; 2 Theme Lectures; 3 Public Lectures by Nobel Laureates; 2200 Delegates; 28 Best Poster Awards ; 43 Exhibitors.

Year 2007: 1-6, July 2007; 18+6 Symposia; 9 Plenary Lectures; 2 Theme Lectures; 2 Public Lectures by Nobel Laureates; 2300 Delegates; 25 Best Poster Awards; 41 Exhibitors.

➤ Highlights of previous National Conferences

Year 2004: 6 Aug., 2004; 20 Invited Talks; 130 Poster Papers; 4 Best Poster Awards .

Year 2006: 18-20, Jan., 2006; Includes the Symposium on 'Physics and Mechanic of Advanced Materials'; 60 Invited Talks; 200 Poster Papers; 1 Public Lecture; 5 Best Poster Awards.

Year 2008: Feb., 25-27, 2008. Incorporated the MRS-I Mumbai (India)-Chapter Joint Indo-Singapore Meeting; 2 Keynote Talks, 60 Invited Talks; 211 Poster Papers; 10 Best Poster Awards.

MRS-S Executive Committee

(For 2009–2010)

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NUS: National University of Singapore

NTU: Nanyang Technological University, Singapore

IBN: Institute of Bioengineering and Nanotechnology, Singapore

Rep Poly: Republic Polytechnic, Singapore

IMRE: Institute of Materials Research & Engineering, Singapore

IHPC: Institute of High Performance Computing, Singapore

Highlights of Recent Literature*(Contributed by the Editor)***Temperature-induced A–B Intersite Charge Transfer in an A-Site-Ordered $\text{LaCu}_3\text{Fe}_4\text{O}_{12}$ Perovskite**

Mixed oxides with the perovskite structure, ABO_3 (A and B are metals) are known to possess interesting physical properties [1]. In recent years, A-site-ordered double perovskites, $(\text{A}'\text{A}_3)\text{B}_4\text{O}_{12}$ ($\text{A}' = \text{Na}, \text{Ca}, \text{La}; \text{A} = \text{Cu}$) have received much attention owing to their special ordered structures and exhibition of a wide variety of physical properties. While those with $\text{B}^{4+} = \text{Ti}$ and Ru can be synthesized under ambient pressure conditions (and high temperatures), those with $\text{B} = \text{V}, \text{Mn}, \text{Fe}$ and Sn can only be prepared under high pressure- high temperature conditions.

Recently, Long *et al.* [2] prepared the compound with $\text{B} = \text{Fe}$, viz., $(\text{LaCu}_3^{3+})\text{Fe}_4^{3+}\text{O}_{12}$ at a pressure of 10 Gpa and at 1130°C, and reported its physical properties. It adopts a cubic structure. At room-temperature (300 K), it is cubic ($a \sim 7.43\text{\AA}$) and is an antiferromagnetic insulator. On heating to 393 K, the mixed oxide is found to undergo a transition to a paramagnetic and metallic state. This transition is reversible. There was no change in the cubic crystal symmetry at the transition, but there was an abrupt drop in the unit cell volume, by $\sim 1\%$, on heating. The authors attribute this transition to the inter-site electronic (hole) charge transfer between the A-site Cu and B-site Fe ions: $(\text{LaCu}_3^{3+})(\text{Fe}_4^{3+})\text{O}_{12} \leftrightarrow (\text{La}^{3+}\text{Cu}_3^{2+})(\text{Fe}^{3+}\text{Fe}_3^{4+})\text{O}_{12}$ (Nominally, the valency-state of iron above 393 K is $\text{Fe}^{3.75+}$).

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1. G. V. Subba Rao and B. V. R. Chowdari, MRS-S OUTLOOK, **1** (1), 8–14 (2006).
2. Y. W. Long, N. Hayashi, T. Saito, M. Azuma, S. Muranaka and Y. Shimakawa, *Nature*, **458** (No.7234), 60–63 (2009) (5 March Issue).

Battery Materials for Ultrafast Charging and Discharging

Rechargeable Li-ion batteries (LIBs) are the batteries of choice nowadays for portable electronic devices like, cell phones, camcorders and notebook computers. They employ a mixed-oxide, LiCoO_2 as the positive electrode (cathode) and graphite as the anode (negative electrode). Goodenough and coworkers [1] in 1997 have shown that a mixed-oxide, LiFePO_4 acts as a 3.5 V cathode, and can replace the 4V-cathode, LiCoO_2 for use in second generation LIBs. In recent years, carbon-coated LiFePO_4 has been developed and found its way into some of the commercial LIBs. For applications in portable power tools and electric/hybrid electric vehicles (EV/HEV), the present-day LIBs need to be improved with respect to their capacity as well as the current (C-) rate capability, with due consideration to the cost and safety-in-operation aspects.

Recently, Kang and Ceder [2] reported that high C-rates can be realized in LiFePO_4 by suitable coating of glassy lithium phosphate, a fast Li-ionic conductor on to the nano-particles of the host material. The synthesized battery-active material has the composition, $\text{LiFe}_{0.9}\text{P}_{0.95}\text{O}_{4-\delta}$. Using a composite electrode containing 15 wt. % carbon, they found that at 2C-rate, the estimated theoretical capacity is delivered when cycled in the appropriate voltage window. Here, 1C-rate is defined as the full discharge in 1 h. At the end of 50 charge-discharge cycles at rates of 20C and 60C, there was no significant capacity loss. In addition, using a composite electrode containing 65 wt. % carbon the authors noted that extremely high rates can be achieved for the active material: at a 200C rate (corresponding to an 18-sec total discharge), a capacity more than 100 mAh/g can be achieved, and a capacity of 60 mAh/g is obtained at a 400C rate (9- sec to full discharge). The authors point out that, 'such discharge rates are two orders of magnitude larger than those used in today's LIBs'.

For a critical discussion of the above paper, see, Zaghbi *et al.* [3].

The results of Kang and Ceder [2] can not be trusted, and need to be reproduced/repudiated by other groups.

References

1. A. K. Padhi, K. S. Nanjundaswamy and J. B. Goodenough, *J. Electrochem. Soc.* **144**, 1188–1194 (1997).
2. B. Kang and G. Ceder, *Nature*, **458** (No.7235), 190–193 (2009) (12 March Issue).
3. "Unsupported claims of ultrafast charging of LiFePO_4 Li-ion batteries", K. Zaghbi, J. B. Goodenough, A. Mauger and C. Julien, *J. Power Sources* (in press, 2009).

Omnidirectional Printing of Flexible, Stretchable, and Spanning Silver Microelectrodes

Recently, Ahn *et al.* [1] have demonstrated the omnidirectional printing of flexible, stretchable, and spanning microelectrodes with the use of tailored silver nanoparticle inks. By carefully controlling the silver nanoparticle concentration, size, and distribution, they have produced inks with high solids-loading that are ideally suited for direct-write assembly. Further, they have shown that self-supporting microelectrodes in either planar- or 3D-forms of arbitrary complexity can be patterned on a wide variety of substrates (e.g., semiconductor, plastic, and glass), and demonstrated the feasibility of wire bonding to fragile devices and patterning complex interconnects for solar cell and light-emitting diode arrays.

Reference

1. B. Y. Ahn, E. B. Duoss, M. J. Motala, X. Guo, S.-I. Park, Y. Xiong, J. Yoon, R. G. Nuzzo, J. A. Rogers and J. A. Lewis, *Science*, **323** (No. 5921), 1590–1593 (2009) (20 March Issue).

Electromotive Force and Huge Magnetoresistance in Magnetic Tunnel Junctions

The electromotive force (*emf*) predicted by Faraday's law reflects the forces acting on the charge, $-e$, of an electron moving through a device or circuit, and is proportional to the time derivative of the magnetic field. This conventional *emf* is usually absent for stationary

circuits and static magnetic fields. There are also forces that act on the spin of an electron; it has been recently predicted that, for circuits that are in part composed of ferromagnetic materials, there arises an *emf* of spin origin even for a static magnetic field. This *emf* can be attributed to a time-varying magnetization of the host material, such as the motion of magnetic domains in a static magnetic field, and reflects the conversion of magnetic to electrical energy.

Recently, Hai *et al.* [1] have shown that such an *emf* can indeed be induced by a static magnetic field in magnetic tunnel junctions containing MnAs quantum nanomagnets. The observed *emf* operates on a timescale of approximately 10^2 – 10^3 sec., and results from the conversion of the magnetic energy of the superparamagnetic MnAs nanomagnets into electrical energy when these magnets undergo magnetic quantum tunneling. As a consequence, a huge magnetoresistance of up to $10^5\%$ is observed for certain bias voltages. According to the authors, ‘the huge magnetoresistance and *emf* may find potential applications in high sensitivity magnetic sensors, as well as in new active devices such as ‘spin batteries’.

Reference

1. P. N. Hai, S. Ohya, M. Tanaka, S. E. Barnes and S. Maekawa, *Nature*, **458** (No.7237), 489–492 (2009) (26 March Issue).

Iron-Based Catalysts with Improved Oxygen Reduction Activity in Polymer Electrolyte Fuel Cells

Iron-based catalysts for the oxygen-reduction reaction (ORR) in polymer electrolyte membrane fuel cells have been poorly competitive with platinum (Pt) catalysts. The authors report on the preparation of microporous carbon-supported iron-based catalysts with active sites believed to contain iron cations. They show that the current density of a cathode made with the best iron-based electrocatalyst prepared by them can equal that of a Pt-based cathode (with a loading of $0.4 \text{ mg of Pt/cm}^2$), at a cell voltage of $\geq 0.9 \text{ V}$.

Reference

1. M. Lefevre, E. Proietti, F. Jaouen and J.-P. Dodelet, *Science*, **324** (No. 5923), 71–74 (2009) (3 Apr., Issue).

Longitudinal Unzipping of Carbon Nanotubes to form Graphene Nanoribbons

Narrow Graphene Nanoribbons from Carbon Nanotubes

Graphene, or single-layered graphite, with its high crystallinity and interesting semimetal-type electronic properties, is considered as an exciting two-dimensional material showing promise for the fabrication of nanoscale devices. Thin, elongated strips of graphene that possess straight edges, termed graphene nanoribbons (GNRs), gradually transform from semiconductors to semimetals as their width increases. To realize the practical potential of the graphene and GNRs, methods for their mass production are needed.

Two methods, namely ‘Longitudinal... nanoribbons’ and ‘Narrow... nanotubes’, have been reported recently, by Kosynkin *et al.* [1] and Jiao *et al.* [2], respectively in which multiwalled carbon nanotubes (MWCNTs) are ‘unzipped’ and rolled open to produce graphene sheets and GNRs.

The method of Kosynkin *et al.* [1] involves treating MWCNTs (consisting of 15–20 concentric cylinders, with diameters of 40–80 nm) with concentrated sulphuric acid followed by addition of potassium permanganate (an oxidizing agent) at room temperature, and finally heating them at 55–70°C. This process chemically unzips the nanotubes, forming nanoribbons up to $4 \mu\text{m}$ long, with widths of 100–500 nm and thicknesses of 1–30 graphene layers. The products are found to be highly soluble in water and in polar organic solvents.

The method of Dai *et al.* [2] involves partial encapsulation of MWCNTs in a polymer. The exposed part of the nanotube is cut by Ar-plasma etching, so that the nanotube unzips when the polymer is removed, leaving a very thin strip of GNR. The GNRs so produced were found to have smooth edges and a narrow width distribution (10–20 nm). The authors also fabricated and tested three-terminal devices with the above GNRs.

Reference

1. D. V. Kosynkin, A. L. Higginbotham, A. Sinitskii, J. R. Lomeda, A. Dimiev, B. K. Price and J. M. Tour, *Nature*, **458**, 872–876 (2009) (16 April Issue).
2. L. Jiao, L. Zhang, X. Wang, G. Diankov and H. Dai, *Nature*, **458**, 877–880 (2009) (16 April Issue).

Structure and Superconductivity of the Intercalation Compounds of TiNCl with Pyridine and Alkali Metals as Intercalants

The metal nitride halides, MNX (M=Ti, Zr, Hf; X=Cl, Br, I) are known to crystallize in a layer structure, the α -form (FeOCl-type) and the β -form (SmSI-type). All the compositional combinations of the β -forms of MNX (M=Zr, Hf; X=Cl, Br, I) are semiconductors with band gaps larger than 3–4 eV, and form intercalation compounds with alkali metals and become superconductors. The highest superconducting transition temperature (T_c) has been recorded at 25.5 K for the Li and THF (tetrahydrofuran) co-intercalated β -HfNCl, namely, $\text{Li}_{0.48}(\text{THF})_y\text{HfNCl}$.

Yamanaka *et al.* [1] recently reported that the α -TiNCl also forms intercalation compounds with pyridine (Py) and alkali metals (A = Li, Na, K, and Rb), and they exhibit superconductivity: $(\text{Py}_{0.25})\text{TiNCl}$ with a $T_c = 8.6$ K; $(\text{A}_x)\text{TiNCl}$, $x \sim 0.19$ to 0.22, with a $T_c \sim 16.3$ K. Surprisingly, in the latter compounds, T_c is independent of the nature of A, but, the superconducting volume fraction is highest at 31.0% for A=K. The authors state that, ‘ab initio electrical band calculations suggested that the Py and A-metal intercalated compounds have different density of states (DOS) profiles, and should have different characters in superconductivity’.

Reference

1. S. Yamanaka, T. Yasunaga, K. Yamaguchi and M. Tagawa, *J. Mater. Chem.*, **19**, 2573–2582 (2009).

N-Doping of Graphene Through Electrothermal Reactions with Ammonia

It is known that graphene (single-atom-thick layer of graphite) is readily p-doped by adsorbates from

the ambient atmosphere; however, for device applications, it would be useful to access the n-doped material. Wang *et al.* [1] recently reported that individual graphene nanoribbons (GNTs; long strips only tens of nanometers in width) can be covalently functionalized by nitrogen species through high-power electrical joule heating in NH_3 gas, leading to n-type (electronic) doping. X-ray photoelectron spectroscopy and nanometer-scale secondary ion mass spectroscopy confirmed the carbon-nitrogen species in graphene thermally annealed in NH_3 . The authors also fabricated and tested an n-type graphene field-effect transistor (FET) that operates at room temperature.

Reference

1. X. Wang, X. Li, L. Zhang, Y. Yoon, P. K. Weber, H. Wang, J. Guo and H. Dai, *Science*, **324**, 768–7718 (2009) (8 May Issue).

White Organic Light-Emitting Diodes with Fluorescent Tube Efficiency

The development of white organic light-emitting diodes (OLEDs) holds great promise for the production of highly efficient large-area light sources. Recently, Reineke *et al.* [1] reported an improved OLED device by combining a carefully chosen emitter layer with high-refractive-index substrates and using a periodic out-coupling structure, and achieved a device power efficiency of 90 lm/W at 1,000 candelas/m², a value higher than that of the common fluorescent tubes. It must be mentioned, however, that the complex organic molecules employed by them contain expensive iridium, and longevity of the device needs to be established.

Reference

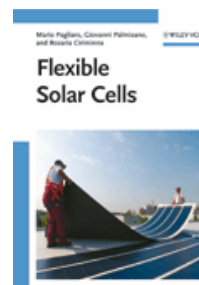
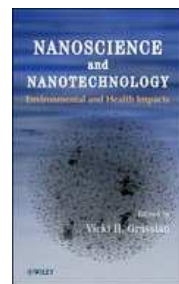
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Recent Books and Review Articles in the Area of Materials Science, Engineering and Technology

(Contributed by the Editor)

Books

- *Nanomaterials and Nanochemistry*. Edited by C. Bréchnignac, P. Houdy and M. Lahmani. Springer, Berlin, 2008. Hardback: 777 pp., illus. \$219. ISBN 9783540729921.
- *Battery Management Systems. Accurate State-of-Charge Indication for Battery-Powered Applications*. Edited by V. Pop *et al.*, Springer, Berlin, 2008. Hardback: 245 pp., illus. \$149. ISBN 9781402069444.
- *Biomimetic Nanoceramics in Clinical Use. From Materials to Applications*. Edited by María Vallet-Regí and Daniel Arcos. RSC Publishing, Cambridge, 2008. Hardback: 185 pp., illus. \$189. ISBN 9780854041428.
- *Compounds and Materials with Specific Properties*. Edited by B. A. Howell, N. Lekishvili and G. E. Zaikov. Nova Science, Hauppauge, NY, 2008. Hardback: 304 pp., illus. \$145. ISBN 9781604563436.
- *Diamond and Related Materials Research*. Edited by Shôta Shimizu. Nova Science, Hauppauge, NY, 2008. Hardback: 467 pp., illus. \$129. ISBN 9781604561456.
- *Glass Materials Research Progress*. Edited by Jonas C. Wolf and Luka Lange. Nova Science, Hauppauge, NY, 2008. Hardback: 312 pp., illus. \$129. ISBN 9781604565782.
- *Nano and Microsensors for Chemical and Biological Terrorism Surveillance*. Edited by Jeffrey B.-H. Tok. RSC Publishing, Cambridge, 2008. Hardback: 220 pp., illus. \$189. ISBN 9780854041404.
- *Progress in Polymer Nanocomposite Research*. Edited by Sabu Thomas and Gennady E. Zaikov. Nova Science, Hauppauge, NY, 2008. Hardback: 425 pp., illus. \$145. ISBN 9781604564846.
- *Research in Hybrid Materials*. Edited by Simon J. Brunner and Julian W. Egger. Nova Science, Hauppauge, NY, 2008. Hardback: 287 pp., illus. \$129. ISBN 9781604567182.
- *Defects in Solids*. Edited by Tilley, Richard J. D. Wiley-VCH, Weinheim, Hardcover. 2008. 530 Pages. 82.90 EUR. ISBN 978-0-470-07794-8.
- *Metal Oxide Catalysis*. Edited by Jackson, S. David and Hargreaves, Justin S. J. Wiley-VCH, Weinheim. 2008. Hardcover. 866 Pages. 2 Volumes. 279.- EUR. ISBN 978-3-527-31815-5.
- *Nanoscience and Nanotechnology Environmental and Health Impacts*. Edited by Grassian, Vicki H. Wiley-VCH, Weinheim, Hardcover. 2008. 470 Pages. 82.90 EUR. ISBN 978-0-470-08103-7.
- *Flexible Solar Cells*. Edited by Pagliaro, Mario, Palmisano, Giovanni and Ciriminna, Rosaria. Wiley-VCH, Weinheim, Hardcover. 2008. 190 Pages. 69.- EUR. ISBN 978-3-527-32375-3.



- *Crystallography and the World of Symmetry*. Edited by Sanat K. Chatterjee. Springer, Berlin, 2008. Hardback: 164 pp., illus. \$139.95. ISBN 9783540698982.
- *Fast Reactions in Energetic Materials. High-Temperature Decomposition of Rocket Propellants and Explosives*. Edited by Alexander S. Shteinberg. Springer, Berlin, 2008. Hardback: 215 pp., illus. \$299. Translated from the Russian edition (2006) by Maria Rusanova. ISBN 9783540788607.
- *Ferroelectric Crystals for Photonic Applications. Including Nanoscale Fabrication and Characterization Techniques*. Edited by Pietro Ferraro, Simonetta Grilli, and Paolo De Natale. Springer, Berlin, 2008. Hardback: 442 pp., illus. \$189.95. ISBN 9783540779636.
- *From Bulk to Nano. The Many Sides of Magnetism*. Edited By Carmen-Gabriela Stefanita. Springer, Berlin, 2008. Hardback: 194 pp., illus. \$149.95. ISBN 9783540705475.
- *Frontiers in Materials Research*. Edited by Yasunori Fujikawa, Kazuo Nakajima, and Toshio Sakurai. Springer, Berlin, 2008. Hardback: 342 pp., illus. \$189. ISBN 9783540779674.
- *Fuel Cells I*. Edited by Günther G. Scherer. Springer, Berlin, 2008. Hardback: 282 pp., illus. \$349. ISBN 9783540697558.
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- *Polymer Membranes for Fuel Cells*. Edited by S. M. Javaid Zaidi and Takeshi Matsuura. Springer, New York, 2008. Hardback: 449 pp., illus. \$129. ISBN 9780387735313.
- *Self-Assembled Nanomaterials I. Nanofibers*. Edited by Toshimi Shimizu. Springer, Berlin, 2008. Hardback: 187 pp., illus. \$229. ISBN 9783540851028.
- *Semiconductor Nanostructures*. Edited by Dieter Bimberg. Springer, Berlin, 2008. Hardback: 379 pp., illus. \$189. ISBN 9783540778981.
- *Sensors Based on Nanostructured Materials*. Edited by Francisco J. Arregui. Springer, New York, 2008. Hardback: 336 pp., illus. \$129. ISBN 9780387777528.
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- *Nanotechnology in Drug Delivery*. Edited by Melgardt M. de Villiers, Pornanong Aramwit and Glen S. Kwon. Springer, New York, 2008. Hardback: 676 pp., illus. \$169. ISBN 9780387776675.
- *One-Dimensional Nanostructures*. Edited by Zhiming M. Wang. Springer, New York, 2008. Hardback: 341 pp., illus. \$129. ISBN 9780387741314.
- *Photoresponsive Polymers I*. Edited by Seth R. Marder and Kwang-Sup Lee. Springer, Berlin, 2008. Hardback: 221 pp., illus. \$229. ISBN 9783540694489.
- *Photoresponsive Polymers II*. Edited by Seth R. Marder and Kwang-Sup Lee. Springer, Berlin, 2008. Hardback: 219 pp., illus. \$269. ISBN 9783540694526.

Review Articles

- Nonhydrolytic Processing of Oxide-Based Materials: Simple Routes to Control Homogeneity, Morphology, and Nanostructure. By P. H. Mutin and A. Vioux, *Chem. Mater.*, **21**(4), 582–596(2009).

Abstract

Over the past decade, there has been an increasing number of reports on low-temperature preparations of oxides and organic-inorganic hybrids (including sol-gel, solvothermal synthesis, and atomic layer deposition) that take place in nonaqueous media. This growing interest lies on the ability of these nonhydrolytic routes (in organic solvents, unusual media, condensed phase or under vapor deposition conditions) to reach a higher control over composition, morphology, and structure. An overview of the main results is presented here, which emphasizes the molecular approach (molecular precursors used, nonhydrolytic reactions involved), the ability to design oxide-based materials with a high degree of homogeneity (mixed oxides, organically modified silicates and ceramics, polysiloxane resins, polymer nanocomposites, etc.) and specific nanostructures (nanoparticles, mesocrystals, nanoporous materials, nanocomposites, nanolayers). 196 References.

- Current Status and Progress of Direct Borohydride Fuel Cell Technology Development. By B. H. Liu and Z. P. Li, *J. Power Sources*, **187**(2), 291–297 (2009).

Abstract

In this article, recent advances in the development of the direct borohydride fuel cell (DBFC) technology are reviewed. Based on the reported results, it is concluded that the BH_4^- electro-oxidation is determined by the catalyst used and BH_4^- concentration at the catalytic sites. Hydrogen evolution during the DBFC operation can be suppressed by: (1) using a composite catalyst or a hydrogen storage alloy as the anode catalyst via a quasi 8-electron reaction; (2) using metals with high hydrogen over-potential, such as Au and Ag as the anode catalyst via an intrinsic 8-electron reaction; and/or (3) modifying and optimizing fuel composition. 87 References.

- Materials Science of DNA. By Y. -W. Kwon, C. H. Lee, D. -H. Choi and J.-I. Jin, *J. Mater. Chem.*, **19**(10), 1353–1380 (2009).

Abstract

The deoxyribonucleic acid (DNA) is a unique class of biomolecule that has many structural features. This article critically reviews the emerging field of DNA materials science, which is expected to add a new horizon to the conventional materials science landscape. A short overview of the recent developments in the non-biological application of DNA and DNA science is given, followed by the roles of DNA in photonics and optoelectronics, DNA-assisted preparation of inorganic nanoparticles and aggregates, and electrical and magnetic properties of DNA, and their influence on nanoscience and technology. The authors also explore the potential applications of DNA in the development of innovative memory and communication devices. Self-assembly and new sensing technologies based on DNA are briefly discussed. 241 References.

- High-Performance SOFC Cathodes Prepared by Infiltration. By J. M. Vohs and R. J. Gorte, *Adv. Mater.*, **21**(9), 943–956 (2009).

Abstract

Solid oxide fuel cells (SOFCs), especially those which can be operated at medium temperatures, 500–700 °C are very attractive for the conversion of chemical to electrical energy. For this purpose, ‘improved’ cathodes are required. Recent work has shown that electrode fabrication and modification by infiltration of active components into a porous scaffold can result in outstanding electrochemical performance. The relevant literature on this new approach is reviewed, and the insights that this work has provided for understanding the relationships between the materials properties, electrochemical performance, and electrode, are discussed. 141 References.

- N, N-Dimethylformamide as a Reaction Medium for Metal Nanoparticle Synthesis. By I. P.-Santos and L. M. L. -Marzán, *Adv. Funct. Mater.*, **19**(5), 679–688 (2009).

Abstract

This Article reviews the use of N,N-dimethylformamide (DMF) for the reduction of metal salts, mainly Au and Ag, while also acting as a solvent. Apart from describing the ability of DMF to reduce metal salts, the effect of different parameters, such as the concentration of capping agent and metal precursors, the presence of preformed seeds acting as catalysts or their crystalline structure, on particle morphology are analyzed. Published reports on the use of different capping agents are summarized, with particular emphasis on the role of poly(vinylpyrrolidone) to determine the morphology of the particles. Finally, a brief overview is provided on the modulation of the optical response in DMF-based metal nanoparticle colloids with tunable size and shape. 64 References.

- Novel Hydrothermal Solution Routes of Advanced High Melting Nanomaterials Processing. By K. Byrappa, *J. Ceram. Soc. Japan*, **117** (No. 1363; March), 236–244 (2009).

Abstract

Novel hydrothermal solution processing routes covering conventional hydrothermal, solvothermal and

supercritical hydrothermal techniques are becoming the most efficient routes for advanced nanomaterials processing including the high melting compounds. The importance of these novel hydrothermal solution routes has been discussed with appropriate examples. The current trends in this area, the importance of solubility study, thermodynamic calculations and the role of surfactants and chelates have been discussed in detail. The multi-energy processing of materials, ‘instant’ hydrothermal system and the new concept in materials processing, viz., ‘chemistry at the speed of light’ have been highlighted. The hydrothermal synthesis of nanomaterials of carbon polymorphs, rare earth vanadates, metal oxides and their nanocomposites have been discussed with an emphasis on the control of size and morphology. 56 References.

- Metal-Free Organic Dyes for Dye-Sensitized Solar Cells: From Structure-Property Relationships to Design Rules. By A. Mishra, M. K. R. Fischer and P. Bäuerle, *Angew. Chem. Int. Ed.*, **48**(14), 2474–2499 (2009).

Abstract

Dye-sensitized solar cells (DSSC) have attracted considerable attention in recent years as they offer the possibility of low-cost conversion of photovoltaic energy. At present, state-of-the-art DSSCs based on ruthenium(II)-polypyridyl complexes (Ru-Ppy) as the active material have an overall power conversion efficiency approaching 11% under standard (Global Air Mass 1.5) illumination. However, Ru metal is expensive and the Ru-Ppy requires careful synthesis and tricky purification steps. On the other hand, the metal-free organic dyes (M-F ODs) can be prepared rather inexpensively by following established design strategies. The major advantages of these M-F ODs are their tunable absorption and electrochemical properties through suitable molecular design.

This Review focuses on recent advances in molecular design and technological aspects of M-F ODs for applications in DSSC. Special attention has been paid to the design principles of these dyes and on the effect of various electrolyte systems. Co-sensitization, an emerging technique to extend the absorption range,

is also discussed as a way to improve the performance. In addition, the authors report on inverted dyes for photocathodes, which constitutes a relatively new approach for the production of tandem cells. Special consideration has been paid to the correlation between the molecular structure and physical properties to their performance in DSSCs. 147 References.

- Controlled Deposition of Crystalline Organic Semiconductors for Field-Effect-Transistor Applications. By S. Liu, W. M. Wang, A. L. Briseno, S. C. B. Mannsfeld and Z. Bao, *Adv. Mater.*, **21**(12), 1217–1232 (2009).

Abstract

The search for low-cost, large-area, flexible devices has led to a remarkable increase in the research and development of organic semiconductors, which serve as one of the most important components for organic field-effect transistors (OFETs). In this Review are highlighted the deposition techniques that offer precise control over the location or in-plane orientation of organic semiconductors, focusing on various vapor- and solution-processing techniques for patterning organic single crystals in desired locations. Furthermore, the alignment of organic semiconductors via different methods relying on mechanical forces, alignment layers, epitaxial growth, and external magnetic and electric fields are surveyed. The advantages, limitations, and applications of these techniques in OFETs are also discussed. 151 References.

- A Survey of Energy and Environmental Applications of Glass. By R. K. Brow and M. L. Schmitt, *J. European Ceram. Soc.*, **29**(7), 1193–1201 (2009).

Abstract

Glasses can be engineered with a wide range of properties and in a variety of forms that make them important materials for current and emerging energy and environmental technologies. The increasing worldwide demand for sustainable, environmentally friendly energy supplies, and for access to clean water, will provide glass scientists and manufacturers opportunities to develop new materials for new markets. Glass applications for solar, wind and nuclear power generation are

reviewed, and recent research on new glassy materials for super-capacitors and electrochemical devices is discussed. 93 References.

- Glasses for Solar Energy Conversion Systems. By J. Deubener, G. Hensch, A. Moiseev and H. Bornhöft, *J. European Ceram. Soc.*, **29**(7), 1203–1210 (2009).

Abstract

Solar technologies are projected to increase tremendously over the next ten years. Glasses are playing an important role as transparent materials of photovoltaic (PV) cells and concentrating solar power (CSP) systems. This article reviews recent solar applications. Surface structuring and coating of glasses are shown to improve energy efficiency for solar conversion systems substantially. Encapsulated glass-to-glass PV modules and solar photocatalytic glass surfaces are identified as elements of a green architecture combining renewable power generating, and destruction of air pollutants of urban environments. Emerging solar technologies for power generation, including transparent PV modules, solar chimney and thermoelectric systems may become significant areas of future solar glass applications. 73 References.

- Polymer-Fullerene Bulk-Heterojunction Solar Cells. By G. Dennler, M. C. Scharber and C. J. Brabec, *Adv. Mater.*, **21**(13), 1323–1338 (2009).

Abstract

Solution-processed bulk-heterojunction solar cells have gained serious attention during the last few years and are becoming established as one of the future photovoltaic technologies for low-cost power production. This article reviews the highlights of the last few years, and summarizes the state-of-the-art performance. An outlook is given on relevant future materials and technologies that have the potential to guide this young photovoltaic technology towards the magic 10%-efficiency regime. A cost model supplements the technical discussions, with practical aspects any photovoltaic technology needs to fulfill, and answers to the question as to whether low module-costs can compensate lower lifetimes and performances. 121 References.

- Strengthening Materials by Engineering Coherent Internal Boundaries at the Nanoscale. By K. Lu, L. Lu and S. Suresh, *Science*, **324**(No. 5925), 349–352 (2009).

Abstract

Strengthening materials traditionally involves the controlled creation of internal defects and boundaries so as to obstruct the motion of dislocations. Well-known strategies, however, invariably compromise the ductility, the ability of the material to deform, stretch, or change shape permanently without breaking. The authors outline an approach to optimize strength and ductility by identifying three essential structural characteristics for boundaries, namely coherency with the surrounding matrix, thermal and mechanical stability, and smallest feature size (smaller than 100 nm). They also discuss potential applications for improving failure tolerance, electrical conductivity and resistance to electro-migration of the materials. 34 References.

- Graphene, the New Nanocarbon. By C. N. R. Rao, K Biswas, K. S. Subrahmanyam and A. Govindaraj, *J. Mater. Chem.*, **19**(17), 2457–2469 (2009).

Abstract

Graphene is a nanocarbon possessing, single-, bi- or few- (≤ 10) layers of carbon atoms forming six-membered rings. Different types of graphene have been investigated by a variety of physical characterization techniques. The extraordinary electronic properties of single- and bi-layer graphenes are indeed most unique and unexpected. Other properties of graphene such as gas adsorption characteristics, magnetic and electrochemical properties and the effects of doping by electrons and holes are equally noteworthy. Interestingly, molecular charge-transfer markedly affects the electronic structure and properties of graphene. Many aspects of graphene are yet to be explored, including synthetic strategies which can yield sufficient quantities of graphene with the desired number of layers. In this Article, the authors highlight the synthesis, structure, and properties of different types of graphene, its chemical manipulation and surface properties. The extraordinary sensitivity of graphene to electrochemical doping and to molecular charge transfer are examined in some detail. 63 References.

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Theme Article

From Applied Science to Commercial Application — Synchrotron Radiation as a Broad R&D Platform: Part V

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[This is a six-Part article. Parts I-IV appeared in the previous Issues. Part VI will appear in subsequent issues—Editor.]

7 Soft X-ray Spectroscopy

Synchrotron radiation based X-ray photoemission spectroscopy (XPS) and X-ray absorption spectroscopy (XAS)/X-ray absorption near edge structure (XANES) are powerful tools for studying novel materials from thin films to nanostructures with surface sensitivity. These techniques can offer unique electronic, magnetic, chemical, and even some structural information. The SINS beamline at Singapore Synchrotron Light Source (SSLS) [42] is ideal for the photoemission (XPS/UPS) and XAS to study the surface, interface, and nanostructure science. In the following, several different sample systems will be illustrated to show how these techniques are applied at SINS beamline to give valuable information.

7.1 Carbon Nanomesh

The first sample system is the carbon nanomesh surface formed on 6H–SiC (0001). Recently, intense efforts have focused on the fabrication of two-dimensional self-assembled nanotemplates that have preferential sites that accommodate individual nanostructures favoring the formation of well-ordered nanometer-sized functional arrays. In particular, an interesting nanotemplate of $6\sqrt{3}\times 6\sqrt{3}R30^\circ$ reconstruction on 6H–SiC (0001) resembling a honeycomb structure with unit cells with diameter of about 2 nm (see Fig. 47) attracts lots of interest due to the potential for the growth of size-controlled metal clusters. However, the atomic structure of the surface, although critical for the application, is still not well understood. With the help of XPS combined with scanning tunneling

microscopy (STM), low energy electron diffraction (LEED), and density-functional theory (DFT) calculations, we are able to propose that the origin of the carbon nanomesh template arises from the self-organization of excess carbon atoms forming a novel honeycomb arrangement atop the 6H–SiC(0001) surface.

The C 1s core-level spectra for the $\sqrt{3}\times\sqrt{3}R30^\circ$ surface after subsequent heat treatments are shown in Fig. 48. To increase the surface sensitivity, a photon energy of 350 eV and an emission angle of 40° were used, giving an electron escape depth of about 2.6 Å [43]. First, the 3×3 surface was prepared by annealing the SiC substrate at 850°C under silicon flux for 2 min. The 3×3 reconstruction was confirmed by LEED and STM. The surface was then annealed at 950°C for 5 min in the absence of Si flux and a sharp $\sqrt{3}\times\sqrt{3}R30^\circ$ LEED diffraction pattern was formed. The C 1s core-level spectrum (Fig. 48 (a)) is dominated by the bulk SiC peak at a binding energy of 282.9 eV. The $\sqrt{3}\times\sqrt{3}R30^\circ$ surface was free of oxygen and other contaminants, as determined by the wide scan PES spectrum using a photon energy of 700 eV (not shown here). Further annealing at 1050°C for 5 min led to the formation of a “ $\sqrt{3}\times\sqrt{3}R30^\circ$ + carbon nanomesh mixed surface”. A new component peak at 285.1 eV appears in the C 1s spectrum in Fig. 48(b). The “pure carbon nanomesh surface” was formed after annealing the SiC substrate at 1100°C for 5 min. At this stage, the 285.1 eV peak dominates the C 1s spectrum (Fig. 48(c)) accompanied by a shoulder at 238.8 eV; the bulk-related SiC component at 282.9 eV

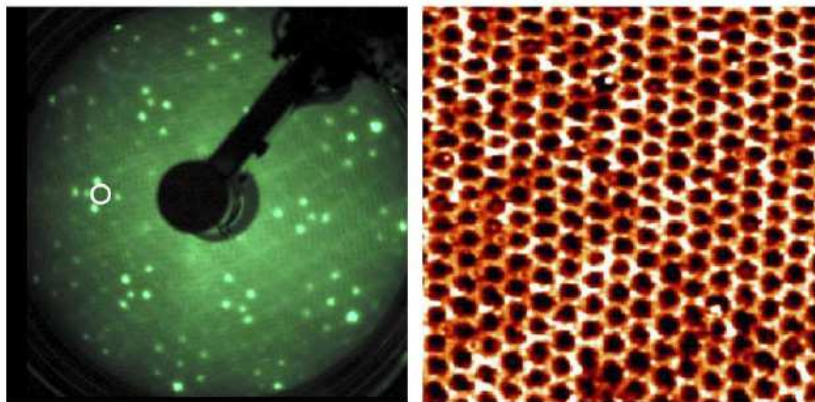


Fig. 47. LEED patterns (left) and corresponding $30 \times 30 \text{ nm}^2$ filled state STM images (right) of “well-developed carbon nanomesh surface” on 6H-SiC(0001). LEED incident beam energy: 70 eV [43].

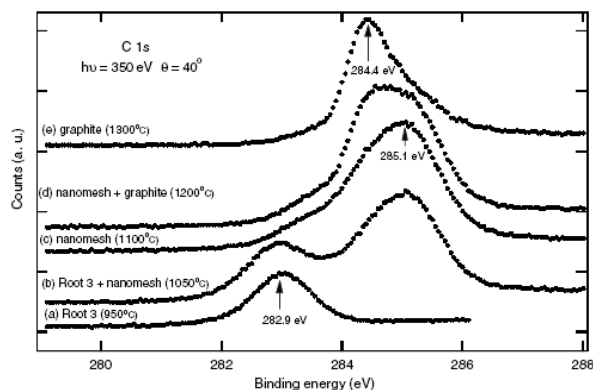


Fig. 48. C 1s core-level spectra recorded from the $\sqrt{3} \times \sqrt{3} R30^\circ$ surface and after different heat treatments, measured at a photon energy of 350 eV and an emission angle of 40° . (a) $\sqrt{3} \times \sqrt{3} R30^\circ$ surface, (b) $\sqrt{3} \times \sqrt{3} R30^\circ$ + carbon nanomesh mixed surface, (c) pure carbon nanomesh surface, (d) carbon nanomesh + graphite mixed surface and (e) graphite surface [43].

is almost gone. Further annealing at 1200°C for 5 min leads to formation of “nanomesh + graphite mixed surface” and annealing at 1300°C for 5 min causes graphitization of the SiC surface [43].

We now focus on the pure carbon nanomesh surface. Fig. 49 shows C 1s core-level spectra from the “pure carbon nanomesh surface” at two emission angles of 90° and 40° using a photon energy of 350 eV. The raw data are shown by black dots. The results of the curve-fitting of the C 1s spectra are also shown in Fig. 49. For the surface sensitive mode at an emission angle of 40° , the C 1s spectrum is dominated by a broad surface related structure, which contains at least two components: a strong component (S1) located at 285.1 eV and a weaker one (S2) at 283.8 eV. For the less surface sensitive mode at an emission angle

of 90° , the bulk-related component (B) at 282.9 eV is enhanced. Simple attenuation models were used to estimate the thickness of the C species on the carbon nanomesh surface using the C 1s spectrum data of the carbon nanomesh [43].

Combining STM and photoemission results with pseudopotential density-functional theory (DFT) calculations, we proposed a model that contains three SiC bilayers covered by isolated carbon domains that represent the nanomesh structure [43] as shown in Fig. 50. More details about this study may be found in Ref. [43].

7.2 Nanographite Films

X-ray absorption spectroscopy (XAS)/near-edge X-ray absorption fine structure spectroscopy (NEXAFS) is

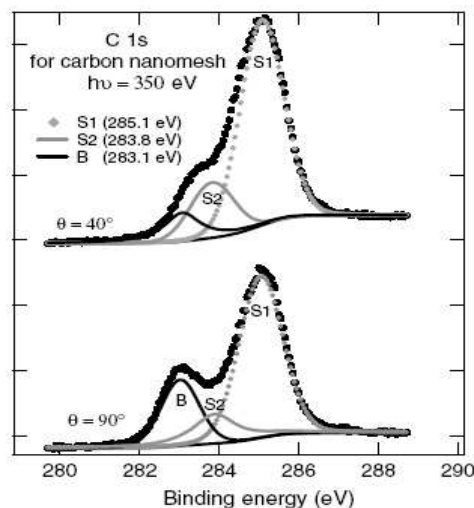


Fig. 49. C 1s core-level spectra recorded from the “pure carbon nanomesh surface” using a photon energy of 350 eV and emission angles of (a) 40° and (b) 90° [43].

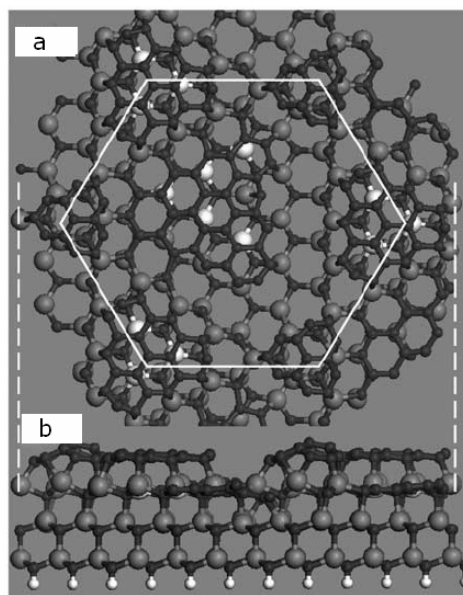


Fig. 50. (a) top view and (b) side view of the 6×6 model, the small dark spheres represent C atoms, big grey spheres for Si atoms, big white spheres for the Si atoms with dangling bonds, and small white spheres for H atoms. The white hexagon highlights the honeycomb unit cell in the STM images [43].

a transition from certain core-level to the unoccupied states and thus depends both on core-level and the unoccupied states, which makes it also known as a chemically sensitive technique. Upon excitation by X-ray absorption the core hole decays via two pathways: the Auger process and fluorescence decay.

The Auger process generates an avalanche of electrons including a large number of inelastically scattered secondary electrons. All these electrons and the fluorescence intensity can be used as signal sources for XAS experiments with different probing depths [44]. This offers the possibility of obtaining depth-resolved

information by combining different detection modes for XAS with different probe depths.

We studied one kind of graphite-like carbon CVD films (later referred to as nanographite films) using XANES with two different detection modes: Auger electron yield (AEY) by detecting C KVV Auger electrons and total electron yield (TEY) by measuring sample drain current. The probe depth of TEY-XAS depends on the escape depths of both secondary electrons and Auger electrons, the latter being a function of the kinetic energy of Auger electrons [45]. The direct detection of the primary Auger electrons as signal source for XAS should result in a shorter probe depth compared to TEY due to the short inelastic mean free path (IMFP) of Auger electrons with kinetic energies of several hundred eV, typically less than 10 Å [46]. Combining both modes, we should be

able to obtain depth-resolved information about the nanographite films.

Figure 51 shows C K-edge XANES of nanographite films at two different thicknesses. For the thin film, it is clear that both TEY and AEY gives spectrum like graphite XANES structures, which shows the film are more or less graphite-like materials [47]. However, it is not the case for thicker film. Even though the AEY still gives spectrum similar to graphite XANES, TEY shows complete different spectrum which is similar to diamond XANES [48]. Considering the different probe depth of the both modes, it is clear that the surface of nanographite film remains the graphite-like and the deeper material is turned to be diamond-like. This result shows clearly how the chemical state of these nanographite films evolve as film thickness increases.

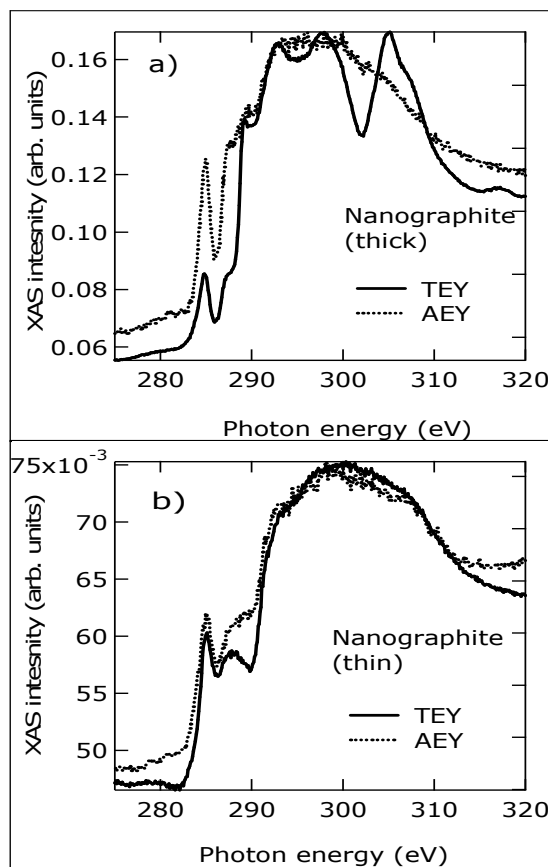


Fig. 51. C K-edge XANES of nanographite films at two different thicknesses (thin film in (a) and thick film in (b), respectively). The solid lines are recorded using TEY and dashed lines are recorded using AEY.

7.3 Regioregular Poly(3-Hexylthiophene) Thin Films

Another example is the study of the orientation and interchain order at both the air and substrate interfaces of regioregular poly(3-hexylthiophene) thin films, which makes use of the angle dependence of C K-edge NEXAFS using linearly polarized light from SINS beamline. The interface structures of polymers are of considerable scientific and technological interest. In the case of conjugated polymers, the correlation of interchain order and orientation with field-effect mobility within the interfacial layer is a vital objective.

In contrast to grazing-angle X-ray diffraction (GIXRD) for the study of surface structure, NEXAFS is very useful because it does not require long range order and it is not sensitive to the film roughness. Thus it can provide structural information on any co-existing amorphous domains, where GIXRD is powerless.

Figure 52 shows a typical set of spectra for the chloroform spin-cast film. The small dichroism indicates that the frontier polymer chains are not well oriented at all in typical spin-cast films. The assignment of thiophene π^* (lowest-lying transition at 285.2 eV), CS^* (287.0 eV), and thiophene and alkyl side chain

CH^* (first transition at 287.4 eV) and alkyl side chain $CC \sigma^*$ (several transitions spread over 292.6–301.7 eV) resonances is well established through the thiophene, oligothiophenes, polythiophene, alkanes and alkyl SAMs NEXAFS literature. The transition dipole moment for the thiophene $C1s \rightarrow \pi^*$ is perpendicular to the ring plane. Its average orientation can be extracted from its polarization dependence normalized to the edge-jump. This gives also the average tilt angle of the $\langle \alpha \rangle$ ring relative to the film plane and thus also of the local chain segment. The measured $\langle \alpha \rangle$ ring values fall within a narrow range of 57–60° (uncertainty $\pm 2^\circ$), slightly larger than the magic angle. We studied different films with totally four solvents and found that solvent conditions markedly affect interchain order, but not the average orientation at the frontier layers of these interfaces which has a slight predominance of out-of-plane stacking of the rings [49].

7.4 Copper Phthalocyanine on Si(111)

The nucleation and growth of organic molecular thin film systems has been shown to demonstrate qualitative differences to that for inorganic systems.

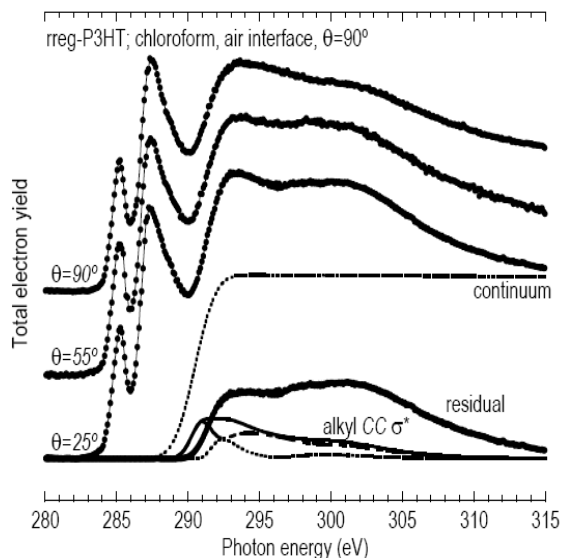


Fig. 52. NEXAFS spectra of high-molecular-weight regioregular poly(3-hexylthiophene) thin film from chloroform, as a function of incidence angle. Bottom spectral decomposition shows explicitly the fitted continuum step, the polarized (dotted line) and un-polarized (dashed line) alkyl $CC \sigma^*$ component spectra, the sum alkyl $CC \sigma^*$ spectrum (solid line) and the residual spectrum of the polythiophene backbone [49].

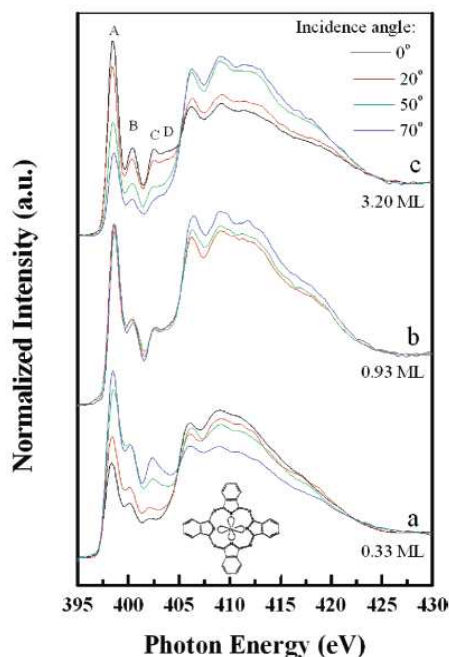


Fig. 53. Angular-dependent N *K*-edge X-ray absorption spectra for the CuPc layer on the Si surface at various coverages. All spectra are normalized to have the same absorption edge step height. The incidence angle here is defined as the angle between the incident direction of photons and the normal direction of the Si surface. The inset shows the schematic structure of the CuPc molecule. [50]

The orientational degree of freedom for molecules with respect to the lying-down (λ) and standing-up (σ) configurations during the growth of organic films is one of the most important differences. Angular-dependent X-ray absorption spectroscopy (XAS) is a powerful tool for determining molecular orientation in organic layers, even at submonolayer coverages. Copper phthalocyanine (CuPc) was used as a model system to study molecular orientation and order in the initial growth on Si(111) substrate.

Figure 53 reports the angular dependence of N *K*-edge XAS spectra at various coverages. The incidence angle is defined as the angle between the direction of incident photons and the normal of the substrate. The first four sharp absorption peaks (A, B, C, D) are assigned to excitations from N 1s core level to individual π^* states, and the broad absorption features at the higher photon energy side correspond to transitions to σ^* states. It is clear that the angular dependence is quite different for sub-monolayer film and thicker film. The molecules at 0.33ML coverage adopt the lying-down configuration (λ structure). A

transition from λ structure to σ structure is observed with increasing coverage. When the coverage increases to almost 1 ML, the angular dependence of the π^* resonances almost vanishes while the intensities of the σ^* resonances are slightly angular dependent, as shown in Fig. 53.

The molecular orientation as well as the orientational order of an organic layer can be extracted from angular-dependent XAS spectra [50]. The intensity of the first π^* absorption resonance as a function of incidence angle at various coverages is shown in Fig. 54(a). The solutions for tilt angle τ and disorder parameter δ for $A\pi$ at various coverages are shown in Fig. 54(b) [50]. It is noted that the values of the tilt angle and the disorder parameter are mutually dependent. However, the maximum possible value for δ , δ_{\max} (which reflects the range of δ), is independent of the value of the tilt angle. The larger the value of δ_{\max} , the more disordered the molecular orientation. The parameter δ_{\max} as a function of coverage is plotted in the inset of Fig. 54(b).

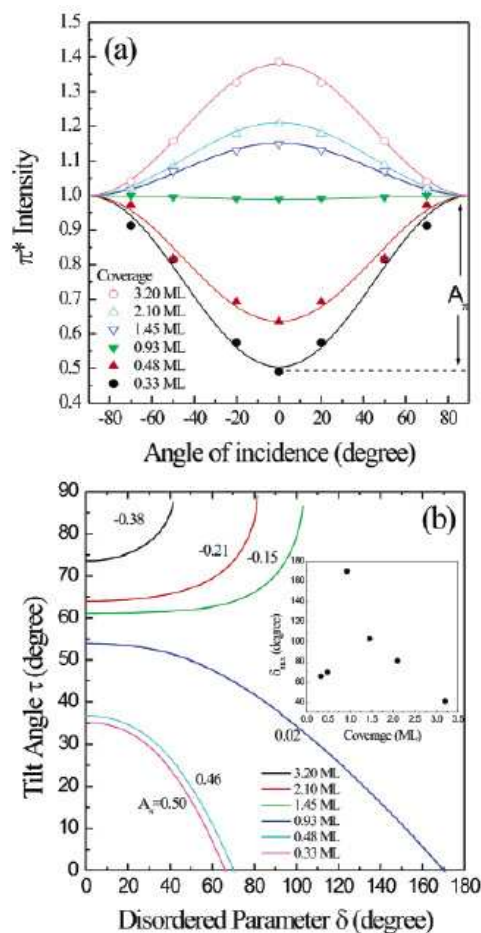


Fig. 54. (a) The intensity of the first π^* absorption resonance for the CuPc layer at various coverages on Si(111) as a function of incidence angle. The intensity modulation amplitude, A_π is defined as $I(\pi/2, \tau, \delta) - I(0, \tau, \delta)$, the difference between the intensity for a resonance take at grazing incidence angle (90°) and normal incidence (0°). (b) The solutions of tilt angle (τ) and disorder parameter (δ) for various A_π corresponding to the layers with different coverages. The inset shows δ_{\max} representing the molecular orientational order of the CuPc layer as a function of coverage. [50]

Below one monolayer, δ_{\max} first increases with coverage, suggesting the molecular orientational order of the layer becomes more disordered. At 0.93 ML, δ_{\max} reaches its maximum at 170° , indicating that the layer is almost completely disordered. Above 1 ML, the molecular orientational order improves with increasing coverage. At 3.20 ML, the narrowest range of δ is observed, indicating that a well-ordered layer has formed. Thus, the XAS results presented above show that the CuPc film experiences such transitions in which not only the molecular orientation varies from λ to σ structures, but the molecular orientational order also significantly varies with coverage. From

XPS study, it was further found that the transition of molecular orientation is related to the changes in the interactions from molecule-substrate covalent interactions to intermolecular interactions.

7.5 Hydrocarbon Adsorption on Diamond (100)

The chemisorption of a range of organic compounds which can potentially undergo cycloadditions with diamond has been studied. These include allyl organics such as allyl alcohol, acrylic acid, and allyl chloride, as well as 1,3-butadiene and acetylene. The surface adsorption of these organics has been verified

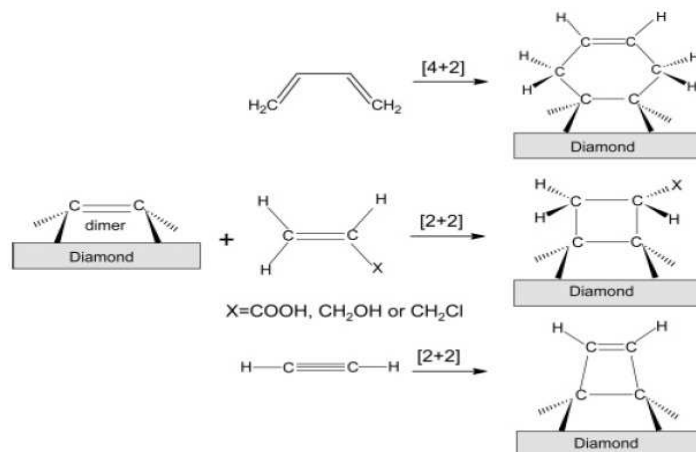


Fig. 55. The schematic diagram of [2 + 2] cycloadditions for 1,3-butadiene, allyl organics and acetylene on the C(100) 2 × 1 surface. [51]

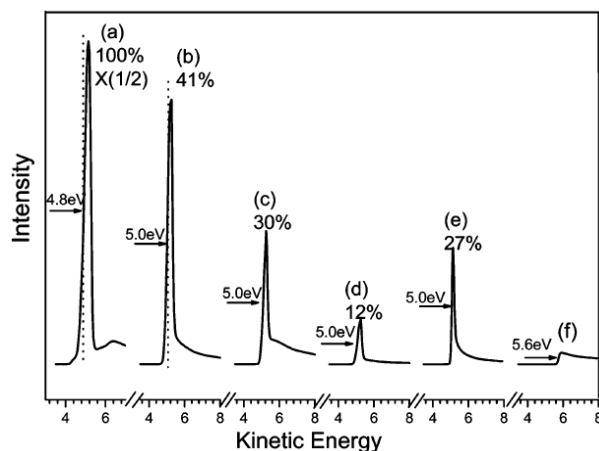


Fig. 56. Secondary electron emission spectra of (a) C(100) 2 × 1-H, and after saturated dosing of (b) 1,3-butadiene, (c) allyl alcohol, (d) acrylic acid, and (e) acetylene; (f) Spectrum of bare diamond C(100) 2 × 1. [51]

by high-resolution electron energy loss spectroscopy (HREELS) as well as synchrotron radiation spectroscopy [51]. The schematic drawing of such reactions for 3-butadiene, allyl organics and acetylene on diamond (100) surface is shown in Fig. 55 [51].

In the following, we will show the electronic properties of the diamond surface can be changed dramatically by the hydrocarbon adsorption. The secondary electron emission spectra (vacuum cutoff of the spectra) are shown in Fig. 56 for H-terminated and bare diamond and after saturation dosages of the various organic molecules. The bare surface has a very weak secondary electron peak with an intensity that

is less than 5% of the hydrogen terminated surface. The low-energy cutoff is situated at ~6 eV, compared to ~5.2 eV for the hydrogenated surface. Thus it is obvious that the bare surface has the condition of positive electron affinity (PEA), while the hydrogenated diamond surface may have negative electron affinity (NEA). Interestingly, dosing the various organic molecules at room temperature also lowers the electron affinity of the diamond surface, by as much as 0.8 eV. As shown in Fig. 56, the intensity of the secondary electron peak was increased from that of the clean surface; according to the descending order of their relative intensities, we have 1,3-butadiene, allyl alcohol,

acetylene, and acrylic acid. 1,3-butadiene was found to show the strongest enhancement of the secondary electron emission condition for room temperature adsorption after saturation exposures. Thus it is clear that the terminal C-H bonds of organics such as 1,3-butadiene, acetylene, and allyl alcohol have the positive end of the dipole facing the vacuum which can lower the electron affinity of the clean diamond significantly. This combination of strong secondary emission and low electron affinity by organic functionalization of diamond surface has potential applications for diamond based molecular electronic devices.

The above examples demonstrate the usefulness of the synchrotron based soft X-ray techniques in the study of novel materials from semiconductor nanostructures to nanomaterials and organic films.

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Materials Education & Research in Singapore

There are two Universities and several Research Institutes in Singapore involved in teaching, research and development in the broad area of Materials Science, Engineering and Technology. These are listed below along with the Websites and provide information on the available courses and opportunities for undergraduate, graduate and post doctoral research. They also entertain queries regarding openings for Research Scientists and Faculty positions.

National University of Singapore: www.nus.edu.sg

Nanyang Technological University: www.ntu.edu.sg

Institute of Materials Research and Engineering (IMRE): www.imre.a-star.edu.sg

Institute of Microelectronics (IME): www.ime.a-star.edu.sg

Data Storage Institute: www.dsi.a-star.edu.sg

Institute of Chemical & Engineering Sciences: www.ices.a-star.edu.sg

Institute of High Performance Computing: www.ihpc.a-star.edu.sg

Singapore Institute of Manufacturing Technology: www.SIMTech.a-star.edu.sg

Institute of Bioengineering and Nanotechnology (IBN): www.ibn.a-star.edu.sg

Forthcoming Conferences

ICMAT2009, Singapore, 28 June – July 3, 2009

The Second Announcement of ICMAT 2009 & IUMRS ICA-2009, calling for Abstracts is available at the website: www.mrs.org.sg

ICCM17, Edinburgh, UK, July, 2009

International Conference on Composite Materials, Edinburgh, UK, 27 – 31, July 2009.

Internationally renowned composites scientists, engineers and designers continue to attend the ICCM series to present their frontier research findings and to keep up to date with latest achievements and developments in this very fast moving and high technology based field. More than 600 delegates from around the world are expected to attend.

Sessions will be led by leading experts with topics in the following main areas: Industry focused Applications; Manufacturing; Materials; Nanocomposites; Behaviour.

For more information, see, <http://www.iccm17.org>

1st Nano Today Conference, Singapore, August, 2–5, 2009

The Institute of Bioengineering and Nanotechnology (IBN) and the Journal, *Nano Today* will be organizing the 1st Nano Today Conference from August 2–5, 2009, at Biopolis, Singapore.

This international conference seeks to bring together researchers interested in nanoscience and nanotechnology, and will present the latest research at the multidisciplinary frontier of nanostructured materials and devices.

Topics of interest include:

- Synthesis and Self-Assembly of Nanostructured Materials and Films.
- Functionalization and Size-Dependent Properties of Nanocrystals, Quantum Dots and Nanowires.
- Processing and Templating of Nanotubes and Nanoporous Materials.
- Tailoring of Polymeric Nanoparticles, Organic-Inorganic Nanocomposites and Biohybrids.
- Fabrication of Nano and Micro Electro Mechanical Systems.
- Design and Engineering of Structural and Functional Nanomaterials.
- Nanosystems for Biological, Medical, Chemical, Catalytic, Energy and Environmental Applications.
- Nanodevices for Electronic, Photonic, Magnetic, Imaging, Diagnostic and Sensor Applications.

Confirmed Plenary Speakers

- Herbert Gleiter, Institute of Nanotechnology Karlsruhe, Germany.
- C N R Rao, Jawaharlal Nehru Center for Advanced Scientific Research, India.
- David A Tirrell, California Institute of Technology, USA.

There are 26 Confirmed Invited Speakers.

Visit www.nanotoday2009.com for more information.

Materials Chemistry 9 (MC9) 2–7, August, 2009 — Glasgow, UK

MC9, is embedded in the 42nd IUPAC (International Union of Pure and Applied Chemistry) Congress to be held at Glasgow, UK during 2–7, Aug., 2009.

The ‘MC’ conference series has provided a showcase for developments in Materials Chemistry every two years for almost two decades. MC8 in 2007 was very successful, and attracted over 480 delegates.

Topics and Symposia: Adaptive Nanomaterials; Biomaterials ; Computational Nanoscience; Crystal Engineering; Green Materials Synthesis; Solid State.

Polymers: Developing Polymer Materials; Polymer Molecular Characterisation; Polymerisation Kinetics

Energy: Catalysis for Energy; Energy Materials: Batteries and Fuel Cells; Hydrogen Storage; Nanomaterials for Energy Conversion; Power Generation.

Electronics and Devices: Molecular Electronics and Magnetics; Molecular Machines and Devices; Organic Electronics.

For more information, see: www.iupac2009.org

High Temperature Materials, USA, September, 14–18, 2009

High Temperature Materials Chemistry Conference –XIII (HTMC-XIII) will be held at Davis, California, USA during September, 14–18, 2009.

For further information, contact, Prof. Alexandra Navrotsky, University of California at Davis, Davis, CA 95616, USA. E-mail: ANavrotsky@UCDavis.edu

11th International Conference on Advanced Materials (ICAM2009), Rio de Janeiro, Brazil, September, 2009

11th International Conference on Advanced Materials (ICAM) will be held in the city of Rio de Janeiro, Brazil, from 20–25, September 2009.

The ICAM is one of the prestigious conferences of the International Union of Materials Research Societies (IUMRS). This conference takes place every other year. The previous conferences were held in China (1999), Mexico (2001), Japan (2003), Singapore (2005) and Bangalore (2007). There will be thirty technical symposia, four plenary lectures, an Energy Forum and an industrial exhibition. Each symposium will have invited talks, contributed oral and poster presentations. More information about this event can be found in www.icam2009.com

A special Symposium: New Developments in the Processing and Applications of Copper and Molybdenum Base Alloys will also be held. This Symposium will bring together researchers from a variety of materials-related disciplines working at the frontier of the processing and applications of Copper and Molybdenum based alloys. An overarching principle will be: Is it possible to find new uses, or improve current ones, for Copper and/or Molybdenum? Within this broad umbrella, all subject matters will be considered, with the following topics being of particular interest:

- (1) Tarnish resistance of antimicrobial copper alloys.
- (2) Copper materials as sanitizing surfaces in medical devices.
- (3) Anti-fouling copper alloys for marine aquaculture cages: challenges and opportunities
- (4) Copper materials in energy systems: solar photovoltaics, advanced batteries, and fuel cell electrodes.
- (5) Production of multichannel copper tubes for high performance heat exchangers.

- (6) Die casting of copper to form the rotors of high efficiency induction motors for industrial and electrical vehicle applications.
- (7) Molybdenum and catalysis.
- (8) Molybdenum ceramic applications.
- (9) Molybdenum and power generation
- (10) Nano-applications of molybdenum.
- (11) Corrosion, inhibitors, electrochemical applications.

The Call for papers with instructions for on-line submission is in the Conference web site, www.icam2009.com

Participants are welcome to participate in this Symposia or in any other of this ICAM event. Participants will have the opportunity to present their research work, exchange ideas, meet friends and colleagues from all over the world and expand their networking. The expected number of participants in the ICAM is about 2000.

Some important dates are: Abstract Deadline: May 1, 2009; Abstract Acceptance: June 30, 2009; Early Registration: July 15, 2009.

For more information and details of the ICAM2009, please visit the web page or send an E-mail to: cu-mo-icam2009@dfi.uchile.cl

International Symposium on Novel Materials and their Synthesis (NMS-V), Shanghai, China, 18–22 October, 2009

Contact Address: Prof. Yuping Wu
Chemistry Department, Fudan University, Shanghai, 200433, China.
E-mail: wuyup@fudan.edu.cn

'Theme Articles' Appeared in 'MRS-S OUTLOOK', Vol. 3, Nos.1–4

From Applied Science to Commercial Application — Synchrotron Radiation as a Broad R&D Platform: Part III

By H. O. Moser¹, K. Banas¹, M. Cholewa¹, C. Z. Diao¹, X. Y. Gao², L. K. Jian¹, S. M. P. Kalaiselvi¹, Z. J. Li¹, G. Liu¹, T. Liu², S. K. Maniam¹, A. T. S. Wee², P. Yang¹ and Y. Adam Yuan^{3,4}, MRS-S OUTLOOK, 3(1), 12–20(2008).

¹Singapore Synchrotron Light Source, National University of Singapore, Singapore

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³Department of Biological Sciences, National University of Singapore, Singapore

⁴Temasek Life Sciences Laboratory, National University of Singapore and Nanyang Technological University, Singapore

Abstract: In this Part III, thin film characterization by X-ray reflectometry, thickness determination, with selected examples from the authors' work, and anomalous scattering effect in reflectivity are described and discussed.

From Applied Science to Commercial Application — Synchrotron Radiation as a Broad R&D Platform: Part IV

H. O. Moser¹, K. Banas¹, M. Cholewa¹, C. Z. Diao¹, X. Y. Gao², L. K. Jian¹, S. M. P. Kalaiselvi¹, Z. J. Li¹, G. Liu¹, T. Liu², S. K. Maniam¹, A. T. S. Wee², P. Yang¹, X. J. Yu¹ and Y. Adam Yuan^{3,4}, MRS-S OUTLOOK, 3(2), 39–47(2008).

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²*Department of Physics, National University of Singapore, Singapore*

³*Department of Biological Sciences, National University of Singapore, Singapore*

⁴*Temasek Life Sciences Laboratory, National University of Singapore and Nanyang Technological University, Singapore*

Abstract: In this Part IV, advanced long-wavelength protein crystallography, and local structure of dopants in dilute magnetic semiconductors (DMS) studied by X-ray absorption fine structure spectroscopy (EXAFS) are discussed with suitable examples.

Please see: ww.mrs.org.sg for accessing Parts I and II.

Metal Oxide based Diluted Magnetic Semiconductors

By Jiabao Yi and Jun Ding, MRS-S OUTLOOK, **3**(3), 63–73 (2008).

Department of Materials Science & Engineering, National University of Singapore, Singapore 119260

Abstract: In this article, the origin of the room temperature ferromagnetism of oxide based dilute magnetic semiconductors (DMS) is discussed and reviewed. The possible effects of carriers, clusters and defects are described in detail.

Synthesis of Nano Crystalline Oxides

By K. C. Patil¹ and Tanu (Mimani) Rattan², MRS-S OUTLOOK, **3**(4), 90–99 (2009).

¹*Department of Inorganic and Physical Chemistry, Indian Institute of Science, Bangalore 560012, India*

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Abstract: Nanocrystalline oxides are three dimensionally modulated synthetic materials characterized by sizes below 100 nm. The fundamental interest in nano oxides lies in the uniqueness in the chemical, physical, mechanical or optical properties that change between the bulk and nano (molecular) scales. Some of the methods that allow effective production of nanomaterials with the desired phase and composition are: Co-precipitation, Sol-gel, Hydrothermal, Reverse micelle and Redox Methods (1.Flame synthesis, 2. Combustible precursors, 3. Solution combustion).

A brief description of the above methods is given highlighting their merits and limitations. It is concluded that among all the methods discussed here, the combustion or redox methods are simple, fast, energy saving and economical.

INVITATION

**MRS-S members are welcome to
contribute to ‘MRS-S OUTLOOK’**

- To suggest topics and prospective author(s) for ‘thematic’ articles pertaining to the areas of materials science, engineering and technology. These will be of general interest to the students, teachers as well as active researchers. These can be 10–15 pages (A4-size, single spaced) with figures, tables and select references.
- To contribute reports on the recently held conferences and information on the forthcoming conferences.
- To contribute ‘Highlights from Recent Literature’ in the areas of materials science, engineering and technology. These must pertain to the years 2008–2009, and be of general interest to non-specialists, students, teachers as well as active researchers. Each ‘Highlight’ must not exceed 250–300 words, including reference(s). Contributing author(s) and e-mail address(es) will be included under each ‘Highlight’.
- To contribute information about the recent awards and distinctions conferred on the MRS-S members.
- To contribute ‘Letters to the Editor’. They may be edited for brevity, clarity and available space, and the author(s) will be informed.

Information on the above aspects may be communicated to the Editor.

Dr. G.V. Subba Rao
E-mail: phyvsg@nus.edu.sg

The Editorial Board of ‘MRS-S OUTLOOK’ reserves the right to include or not any of the submitted contributions.



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