Society of Nanoscience and Nanotechnology

NANO AFFAIRS

www.nano-society.org

reaching the nano community worldwide...

VOLUME 1, ISSUE 1 APRIL 2007

Welcome to the inaugural issue

I am very pleased to welcome you to this first issue of **Nano Affairs**, the official newsletter of the Society of Nanoscience and Nanotechnology (SNN). SNN was launched to the international community during the recent MPA-2007 meeting held in Belfast. It was great to see so many colleagues from all over the world gather for the launch event. I would like to thank all those who participated and helped out with the smooth running of the meeting.

Nano Affairs will initially be circulated every quarterly and gradually it will turn to monthly. I hope the first issue proves to be informative and extremely beneficial to the very many readers. The newsletter provides opportunity for people to link together, keep up-to-date with current developments, create awareness about nano-related issues and debates them to find some common solution and understanding. Until, the next issue of the **Nano Affairs**, I wish you all the best and enjoy reading the first issue and wait for the second.

Dr Nasar Ali (President, SNN)

Official launch of SNN

The **International Meeting on Developments in Materials, Processes and Applications of Nanotechnology** (MPA), held at the University of Ulster in Belfast, UK on 15 January 2007 officially launched the new **Society of Nanoscience and Nanotechnology** to the international community.

Many world class academics, research scientists and industrialists were present on this occasion. Professor Jeff De Hosson (Netherlands), Professor E. I. Meletis (USA), Professor Stan Veprek (Germany), Professor W. I. Milne (UK), Professor Hans Oechsner (Germany), Professor Werner Blau (Ireland), Professor Sam Zhang (Singapore), Professor John Moore (USA), Professor Jim McLaughlin (UK) and Dr Dave Tolfree (UK) delivered excellent talks on a range of topics relating to various aspects of nanomaterials, nanoscience, nanotechnology and the commercialisation of nanotechnology. All the talks were attended by approx. 200 delegates from worldwide.

Dr Nasar Ali, the general chair of MPA, opened the conference and welcomed all delegates and thanked them for travelling from over 20 countries of the world, including UK, Ireland, USA, France, Spain, Germany, Netherlands, Portugal, Czech Republic, Russia, Singapore, Taiwan, China, Japan, Korea, Egypt, Thailand, Libya and Brazil.

Dr Ali urged all delegates to play a proactive role in helping the society to grow and meet its objectives in accomplishing its mission. During the launch event, over 100 posters were presented and a special panel selected three posters to receive a cash prize of 100GBP each. The prizes for the best Physics, Biology and Chemistry posters were supported by the Institute of Physics (IoP), Institute of Biology and the Royal Society of Chemistry (RSC), respectively. Mr Su Hwan Lee from Korea took the prize for the best Physics poster. The prize for the best Chemistry poster went to Mr Cheng- Te Lin from Taiwan. The prize for the best Biology poster went to Miss Raechelle D'Sa from UK.

For more information on the launch event visit www.mpa-2007.org

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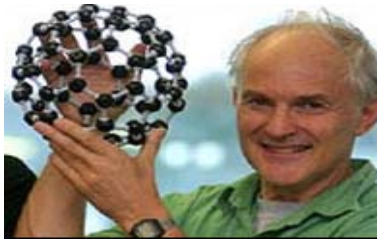
Revolutionary approach to promoting education

Nobel Laureate Sir H. W. Kroto, a professor at Florida State University (US) and also the honorary president of the Society of Nanoscience and Nanotechnology has developed new and novel ways of using the internet to excite young people of all ages about the Sciences, Technology Engineering and Mathematics (STEM). As well as the more obvious STEM technical issues that underpin all aspects of our everyday lives he also sees it as vital that we address humanitarian contributions and social responsibility issues of STEM.



Sir H. W. Kroto, Florida State University

Revolutionary approach to promoting education...

Since joining Florida State University (FSU), Sir Kroto has launched **GEO** – "Global Educational Outreach" – initiative in which he and his team use relatively inexpensive technology to create science programs and make them accessible via the Internet to schools all over the world. Although the initiative has hardly started, the feedback on preliminary tests to schools in Europe and South America has been so enthusiastic that we are confident that this exciting component of the new centre's strategy will make an important contribution to our success. We see it as crucial that we work together with Florida teachers to address some of Florida's and the World's most pressing STEM problems. A particular target is the cohort of teachers which is manfully struggling to cope with the teaching of STEM with minimal resources and training. The first aim is to create a portfolio of modules consisting of the best teaching material available (downloadable via the Internet) together with video presentations of that material by the best teachers worldwide. This is now an entirely feasible objective. Prototypes can be viewed at the GEO website.

The initiative will develop an effective, responsive-mode approach by gradually building up a cache of Internet modules to support the instruction of mathematics and science concepts as selected by Florida teachers who we see as vital in refining the approaches as the scheme develops. The modules will involve recorded presentations by scientists, mathematicians and engineers who are not only expert in their fields but also outstanding teachers. The presentations will be accompanied by synchronized downloadable educational images and scripts (e.g. PowerPoint slides etc). They also will use a variety of Internet technologies, such as video on demand (VOD), video web conferencing, and audio and video podcasts. The primary aim of this revolutionary approach is to empower teachers by giving them high quality, inexpensive materials that will enable them to teach essential concepts, introduce students to science at the cutting edge and encourage them to consider careers in STEM and so make contributions to society and fulfill personal ambitions. In addition a cache of presentations by young scientists mathematicians and engineers who are adept at presenting their research and transmitting enthusiasm for their work is being assembled.

The link for the underline above is:
http://mediasite.oddl.fsu.edu/mediasite/Catalog/Front.aspx?cid=3bd4c40c-e410-4ba4-8594-5b9891cfeefd

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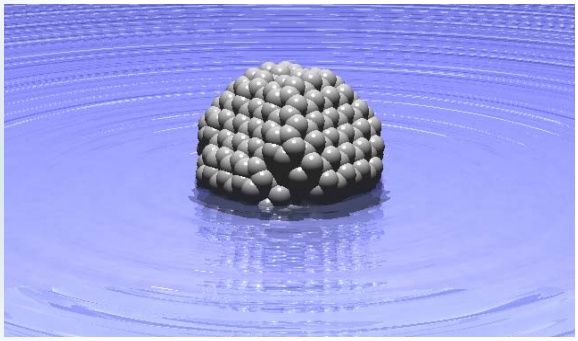
Modeling Nanomorphology: Let's get real

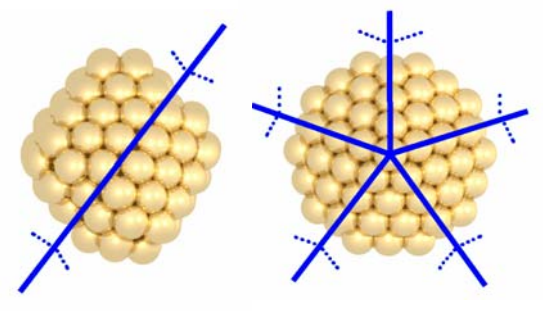
A review of the scientific literature concerning the modeling of nanomorphology (that is, computational and theoretical examination of the structure, shape and phase of nanoscale materials) highlights two common assumptions. The assumption of crystallographic perfection and the assumption of chemical isolation. In contrast, a review of literature reporting the experimental characterization of nanomorphology of real nanomaterials highlights a variety of modifications and defects, and interdependences between shape and chemical environment. In the past, it was common to assume in theoretical studies, for the purposes of simplicity, that colloidal nanoparticles were all spherical, and nanorods (or nanowires) were either elliptical or cylindrical. The only difference between nanowires and nanotubes was that the former were solid, and the latter hollow. More recently, driven by advances in imaging techniques that definitively established the distinct faceting of crystalline nanostructures, theoretical and computational studies have embraced a variety of polyhedral shapes, and the systematic study of nanomorphology has become more popular. However, if we are to model realistic nanostructures, comparable with those examined by our experimental colleagues, there is still a long way to go. Firstly, we must tackle those two comfortable and convenient assumptions listed above, that limit the opportunity for direct comparisons between the theoretical and experimental systems. The first assumption (of crystallographic perfection), logically precludes a number of important and valid structures.

Many nanomaterials are naturally defect-free, due to low diffusion barriers for defects near surfaces, but the beautiful variety of twinning configurations observed in nanoscale fcc metals evidences the fact that crystallographic modifications may be quite stable. Whether they are kinetic or thermodynamic products may be relevant to the method we use to model them, but not to the priority they should take in our research.

New methods for including crystallographic and chemical defects are necessary to assist in this regard, but so is the motivation to use them. The second assumption (of chemical isolation), ignores the important role of surface chemistry, and surfactants in affecting shape and surface structure, and in moderating the morphological stability of samples in storage. Changes in surface chemistry can be as critical to maintaining a desirable shape or structure as changes in temperature. Moreover, when we are modeling complicated surfactant-particle interactions, perhaps a more realistic basis for comparison should be hydrated or oxidized surfaces, as opposed to the clean surfaces that only stay clean in a virtual environment. This type of comparison will become more universally accessible with the emergence of new multi-scale methods, which will also facilitate future studies of interactions between the particles themselves, and the modeling of self-assembly and agglomeration.



Many colloidal nanostructures are not grown, or stored, under vacuum conditions. It is important to accurately represent the chemistry at the surface if we are to model realistic systems.



Colloidal gold nanoparticles often exhibit symmetric (contact) or cyclic twinning, which is often neglected in modeling studies that focus on realistic sizes.

Further information:

Dr Amanda Barnard is currently the Violette & Samuel Glasstone Fellow in the Department of Materials at the University of Oxford, UK. Using primarily thermodynamic theory and *ab initio* computer simulations, her research focuses on the fundamentals of nanomorphology and the role of shape in the moderation of nanoscale properties, including size dependent phase transitions. A fervent advocate of partnering theory and experimentation, her interests lie in the development of multi-scale models dependent upon experimentally relevant factors such as size, composition, temperature, defects and surface chemistry. E-mail: amanda.barnard@materials.ox.ac.uk

Nanotube-tipped pipettes poke cells

A Drexel University (USA) research team has developed a novel class of biological probes for subcellular investigation (*Applied Physics Letters* 90, (2007) 103108). The development of carbon nanotube-tipped pipettes will enable researchers to transfer molecules of interest into and out of an individual cell, nuclei, or organelle through the conjoined nanotube and pipette device. This will allow for controlled substance delivery and quantitative sampling. Davide Mattia and Gulya Korneva, PhD students in Dr. Yury Gogotsi's research team in the Materials Science and Engineering Department, synthesized carbon nanotubes using a template assisted chemical vapor deposition method and filled the tubes with magnetic nanoparticles. Joshua Freedman, a PhD student advised by Drs. Gary Friedman and Adam Fontecchio from Drexel's Electrical and Computer Engineering Department, assembled the probes by injection of mCNTs into glass micropipettes, which are then positioned as probe tips via magnetophoresis, and affixed with polymeric adhesive (Figure 1).

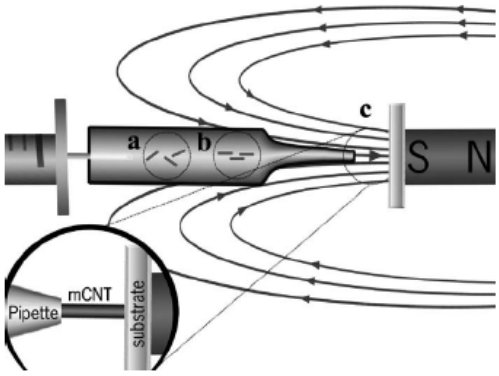


Fig. 1(a) 5 ml of magnetic CNT solution are injected into a pipette using a 30 gauge syringe. (b) As the CNTs approach the magnetic field created by the magnetized wire (right) they align themselves perpendicularly. (c) A thin hydrophilic substrate is placed between the pipette and a powerful magnet. When the pipette is moved within a few microns of the substrate, capillary action pulls the fluid from the pipette until a CNT or CNT bundle is drawn out.

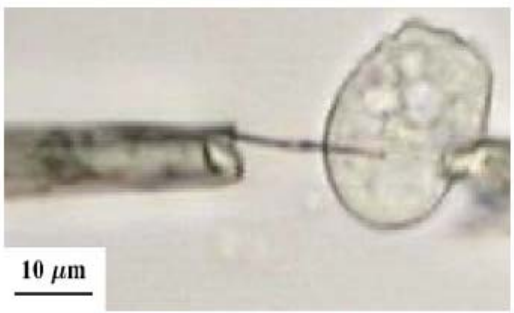


Fig. 2. Optical image of a nanotube tipped pipette (left) injected into a MDCK cell held in place by negative pressure on a patch pipette (right) .Negligible deformation of the cell occurs.

For more information:

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A to Z in reverse (Zilch to Asset) – from surface waste of steel mills to zero valent iron (ZVI) nanoparticles

A unique solvothermal process converts the landfill-bound steel mill's waste into highly active nanoscale iron powder

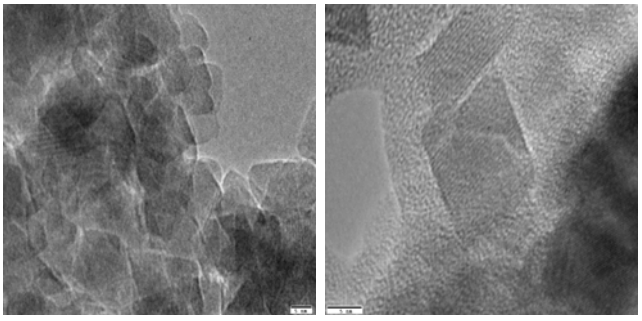
In their quest to find ways to achieve the much-discussed and sought-after *hydrogen economy*, the University of Toledo researchers are employing an 'econo' viable and 'enviro' friendly method - well-known to the metallurgists for centuries - to generate high purity hydrogen, with an interesting twist. The method consists of a reaction between heated iron and steam, also appropriately called 'metal-steam reforming'. The twist lies in the source of iron: They utilize the so-called 'mill-scale' waste from steel industry, as an iron source. Mill-scale is a porous, hard and brittle coating of several distinct layers of iron oxides (predominantly Fe_3O_4) formed during the fabrication of steel structures. It is magnetic in nature with iron content up to as high as 93%. Prior to sale, or use of such steel structures, the steel structures must be cleaned of this oxide scale.

Most of the steel mill-scale waste usually end ups in a landfill. In Russia and Asia, some of the mill-scale waste is also used to make reinforced concrete. A purer commercial form of this oxide in combination with nickel and zinc oxide is used in making soft ceramic magnets which are an integral part of all the audio-visual and telecommunication media on this planet as well those in the space.

The mill-scale waste can be and has been successfully converted into metallic iron via hydrogen reduction and by reaction with carbon (known as carbothermic reduction) as well. This is not a smart way of producing iron from the oxide; both the reduction processes are energy-intensive as they use high temperatures and one of them requires precious H_2. Thus, the regeneration of elemental iron from the spent oxide via these processes is unattractive in a commercial setting and makes the winning of iron from steel waste more expensive than probably dumping it in a landfill! Moreover, the use of high temperatures in the two processes results in the formation of coarser iron that is not so active or 'potent' and is unlikely to generate hydrogen efficiently over several cycles.

So, here is the second element of twist. A novel near room-temperature reduction technique was developed whereby the mill-scale is first brought in solution by acidic dissolution wherein it is instantly converted into highly active nanoscale iron powder (average particle size ~ 20 nm). This new scheme of reduction totally obviates the issue of sintering and coarsening of the iron/iron oxide due to high temperatures and hence the possibility of deactivation during the cyclic operation of metal-steam reforming becomes a non-issue. By modifying the technique and conducting the reduction in the presence of a surfactant, even smaller (~5 nm) iron particles were achieved.

In both these cases an aqueous solution of sodium borohydride ($NaBH_4$) has been used as the reductant; $NaBH_4$ is rather expensive and its solutions unstable. In another case, by using hydrazine as an alternate reductant and ethanol as the solvent under solvothermal conditions (100°C/ 4atm.), iron particles ~5 nm in size have been obtained. This is a significant achievement in that hydrazine is more stable and much less expensive reductant compared to sodium borohydride and, the solvothermal process is easily scalable.



TEM images of iron from solvothermal reduction using hydrazine (bar: 5nm).

These zero valent iron (ZVI) nanoparticles are also relevant as key catalyst in the synthesis of carbon nanotubes that are being considered for a host of applications ranging from hydrogen storage devices to sensors to high strength polymer nanocomposite, owing to their unique hollow structures and exceptional electrical and mechanical attributes. ZVI is being considered as an active decontaminant of drinking water. Perchlorate is a chemical species of grave health concern due to its interference with the activity of the thyroid gland, and therefore its removal from drinking water sources is very desirable. The improvement in water quality has been negatively affected also by the presence of arsenic in ground water. Severe poisoning can arise from the ingestion of as little as 100mg of arsenic trioxide.

Chronic effects may result from the accumulation of arsenic compounds in the body at low intake levels. Arsenite (As^{III}) is many times more toxic than arsenate (As^{V}). The maximum level of arsenic in irrigation water recommended by the Food and Agriculture Organization (FAO) is 0.1 mg/L. The World Health Organization (WHO) recommends that the maximum level of arsenic in drinking water should not exceed 0.01 mg/L (10 ppb). Some countries still accept the level of 0.05 mg/L (50 ppb) in their national standards. Many studies suggest that there is a high possibility of arsenic being taken in by plants from soil or irrigation water, which eventually transfers to humans.

Among several alternatives for arsenic sorption and removal from water, zerovalent iron and its hydrated forms have shown significant propensity of remediation. Some recent research indicates that magnetite (Fe_3O_4) is also effective in arsenic removal from water.

Preliminary experiments conducted at the Lawrence Berkeley National Laboratory, using our ZVI showed that 497 ppb (~0.25 mg/L) of arsenic in water could be removed by ~1 g of the nano iron powder generated from mill-scale waste, by stirring for 50 minutes.

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Broken bonds: the key to the size dependency of nanostructures

The new degree of the freedom of size is indeed fascinating, which not only allows us to tune the physical properties of a specimen but also provides us with new opportunity to derive information that is beyond the scope of traditional approaches. Since the discovery of nanomaterials, there has been great interest in the synthesis and functionalisation aimed towards the development of new functional materials and devices. Compared with the tremendous experimental progress, fundamental understanding of the unusual performance of nanostructures is the key yet remains far from clear.

Recently, Dr Sun Changqing at Nanyang Technological University, Singapore, published a thematic report dealing with the physical origin of the size induced property change of nanostructures [Sun CQ, Size dependence of nanostructures: impact of bond order deficiency", Prog Solid State Chem 35 1-159 (2007)]. By extending the "atomic coordination – atomic size" correlation theory of Pauling [Pauling L, Atomic radii and interatomic distances in metals. J Am Chem Soc 1947;69:542-53] and Goldshdmidt [Goldschmidt VM, Ber Deut Chem Ges 1927;60:1270] to energy domain, Sun proposed and verified the "bond-order-length-strength" (BOLS) correlation mechanism that works quite well in predicting the performance of nanostructures in mechanical strength, thermal and chemical stability, acoustic, photonic, electronic, magnetic, dielectric, and transport dynamic behavior of nanostructures.

The size dependence of nanostructures is attributed to the tunable portion of the under-coordinated atoms in the superficial surface skins of at most three atomic layers in combination with the shorter and stronger bonds between the under-coordinated atoms. Atoms in the core interior of the nanostructures remain as they are in the bulk, making no contribution to the size dependency. The broken bonds induced local strain and the associated depression of the potential well of trapping causes the densification and localization of charge, energy and mass, which modify the atomic coherency (the product of bond number and the single bond energy), electroaffinity (separation between the vacuum level and the conduction band edge), work function, and the Hamiltonian of the nanosolid. Therefore, any detectable quantity can be functionalized depending on the atomic coherency, electroaffinity, work function, Hamiltonian or their combinations. For instances, the perturbed Hamiltonian determines the entire band structure such as the band-gap expansion, core-level shift, Stokes shift (electron-phonon interaction), and dielectric suppression (electron polarization);

The modified atomic coherency dictates the thermodynamic process of the solid such as self-assembly growth, atomic vibration, phase transition, diffusitivity, sinterbility, chemical reactivity, and thermal stability. The joint effect of atomic coherency and energy density dictates the mechanical strength (surface stress, surface energy, Young's modulus), and compressibility (extensibility, or ductility) of a nanosolid. Most strikingly, a combination of the new freedom of size and the original BOLS correlation has allowed us to gain quantitative information about the single energy levels of an isolated atom and the vibration frequency of an isolated dimer, and the bonding identities in the metallic monatomic chains and in the carbon nanotubes. Further extension of the BOLS correlation and the associated approaches to atomic defects, impurities, liquid surfaces, junction interfaces, and amorphous states and to the temperature and pressure domains would be more interesting, challenging, and rewarding.

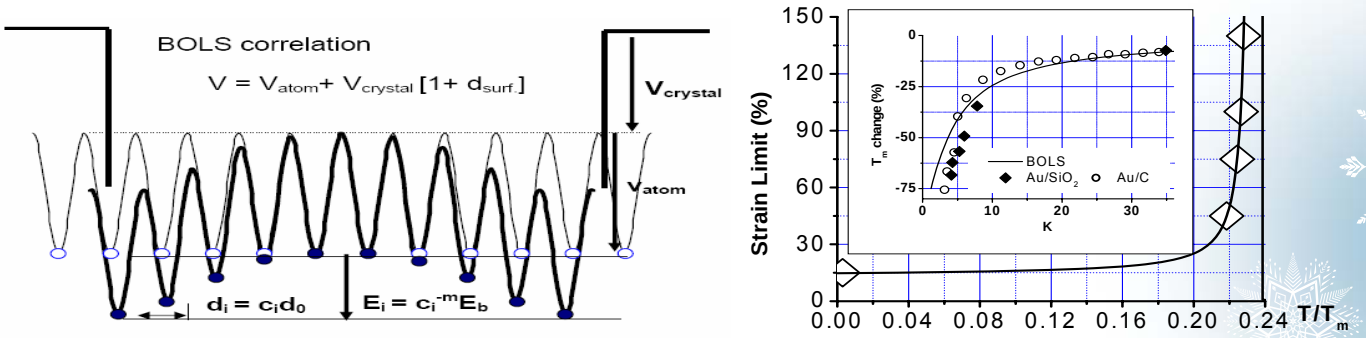

Fig. 1. Illustration of the BOLS correlation mechanism and its application. (a) Broken bonds in the surface skin cause the remaining bonds of the under-coordinated atoms to contract spontaneously associated with bond strength gain or potential well depression, which contribute to the Hamiltonian and atomic cohesive energy and electron affinity and related properties of the nanostructures. (b) Agreement between the maximal strain of Au-Au atomic wire at various temperatures and (insert) the temperature dependence of temperature of melting. K = R/d is the number of atoms lined along the radius of a spherical dot. E_i and d_i is the cohesive energy and bond length of the specific ith atom and c_i the coefficient of bond contraction and m the bond nature indicator.

Further information: contact Dr Sun Chang Qing, FInstP FRSC, NTU, Singapore (www.ntu.edu.sg/home/ecqsun)

Jerky-type phenomena at nanocomposite surfaces: the break-down of Coulomb friction law

From a physics point of view, friction is determined by short- and long range interactions between the surfaces. It involves phonon dissipation, bond breaking and formation, strain-induced structural transformation and local surface reconstruction, and adhesion. The classical friction laws were discovered by da Vinci and Amontons and were summarized much later by Coulomb, who contributed the third friction law, stating that friction is independent of the sliding velocity. Recently it has been shown convincingly that ultralow friction can be tailored in nanocomposite materials and that the results point to a breakdown of the Coulomb friction law (see J. Applied Physics 100, 114309 (2006)). Extremely low friction coefficients of the order of 0.01 were attained. It was found that TiC/a-C nanocomposite coatings deposited via pulsed-DC magnetron sputtering exhibit a columnar free microstructure that is fully dense. XTEM observations have revealed that the non-reactively sputtered nanocomposite coatings exhibit a multilayer structure. The TiC/a-C top coating consists of amorphous DLC embedded with well aligned TiC nanoparticles of sizes ranging between 2 and 5 nanometers, distributed in a Ti-rich sublayer of the multilayer structure (Fig. 1). The size and separation of TiC nano-particles could be monitored independently so as to control the friction coefficient.

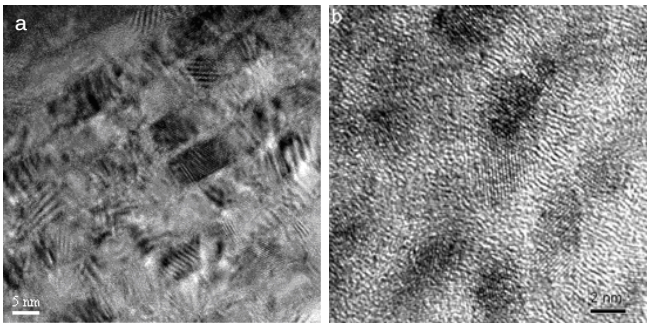

Fig.1 HR-TEM observation of (a) interlayer and (b) top coating

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Conjugation of AFM and SERS for early detection in Nanomedicine

Researchers at the Biophysics & Nanoscience Centre (BNC), University of Tuscia, Viterbo, Italy have applied spectroscopic and nanoscopic techniques in hybrid systems by conjugating biomolecues with metal nanoparticles and electrodes. They are working towards the development of new strategies to apply in nanomedicine.

An emerging task in early diagnostics in medicine is the detection of specific markers at extremely low concentration (less than 10^{-18} M). Indeed, abnormal concentration of certain proteins often signals the presence of various cancers and diseases. However, current protein detection methods (for instance ELISA) only allow revealing protein levels above critical threshold concentrations at which diseases are often significantly advanced. The combination of nanomaterials with different sensing methods (optical, electrical, electrochemical, magnetic) is currently being explored offering advantageous approaches even for multiplexing sensing.

Growing attention is being shed on advanced optical spectroscopies to obtain detection at very low levels of molecules of interest in biodiagnostics (e.g. fluorescence spectroscopy, Surface Plasmon Resonance, Quartz microbalance, Surface Enhanced Raman Spectroscopy (SERS)). SERS occurring when molecules are adsorbed on nanostructured surfaces of noble metals, couples a high sensitivity with a rewarding chemical specificity representing a powerful microanalytical technique with large potentialities in advanced nanodiagnostics (figure 1).

Scanning Probe Microscopy (Atomic Force Microscopy (AFM) and Spectroscopy (AFS), Conductive-AFM, Scanning Tunnelling Microscopy (STM)) provide a new, complementary tool to early diagnostics. AFM imaging can reveal individual ligand-receptor complex formation over a substrate as an upward shift of detected height of the molecules. More importantly, AFS allows probing unbinding forces of individual ligand-receptor pairs by recording force *vs.* distance cycles on surface-bound ligands using a tip functionalised with the receptor (see Fig.2). Furthermore, the employment of a conductive substrate allows for single specific recognition events to be monitored by STM or Conductive–AFM also as a recordable low current signal (as low as 0.1 pA) with spatial resolution in the nanometer range.

The combination of innovative optical and nanoscopic techniques might deserve new possibilities for nano-biosensing. Therefore, it is important that a quantitative correlation among signals coming from the different single-molecule techniques has to be systematically explored even in terms of quantification, sensitivity, reproducibility and feasibility of detection.

Within this framework, the BNC group are working to develop novel automated nanoscreening platforms which, being based on single-molecule multi-technique detection mode, provide enhanced sensitivity and optimal efficacy of the multiplexing biodetection method, favourably competing with the conventional methods of PCR and ELISA.

Particular interest is being shed on the interaction between p53 tumor-suppressor protein and different ligands. p53 is a major player in regulation of cell growth, DNA repair, genomic stability and cell apoptosis, which is functionally inactivated in many human cancers.

Recent work has demonstrated that, in cancer cells, p53 is stabilized by complex formation with the copper protein *Pseudomonas Aeruginosa* Azurin (AZ) and that such complex formation results in an increase of p53 intracellular level for ultimate induction of apoptosis and growth arrest of cancer cells. On such a basis, the study of the interaction between p53 and its ligand AZ can provide insight into the mechanism of complex formation and specificity of the interaction, for enhanced p53 activity in cancer cell apoptosis. In addition, the group at BNC are interested to detect Thrombin, a serine protease that converts soluble fibrinogen into insoluble strands of fibrin whose concentration level in blood is relevant in some diseases. As Thrombin sensitive element, the group have used Antithrombin III, forming a complex with Thrombin molecules.

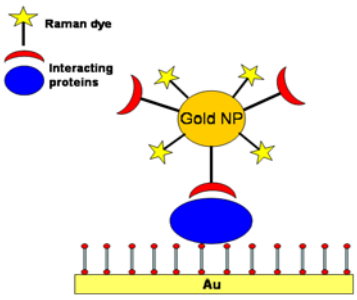

Fig. 1. Gold nanoparticles, labelled with both Raman dyes and target molecules, interact with a protein partner adsorbed on gold modified by a self-assembled monolayer. The system can be investigated by spectroscopic (SERS) and nanoscopic (AFM, Conductive-AFM, STM) techniques.

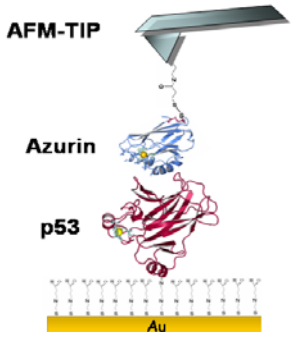

Fig. 2. Atomic Force Microscopy tip functionalized with the electron transfer Azurin & p53 immobilized on gold modified by self-assembled monolayer to perform Atomic Force Spectroscopy (AFS) experiments.

In particular, the BNC group are using gold nanoparticles labelled with Raman dye in connection with gold substrate suitable for performing SERS, AFS and Conductive-AFM experiments (see Figs.1 and 2). Such an approach might offer increased versatility and wide-application as detection method.

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Diamonds from Argonne

Argonne National Laboratories in US provide the worldwide leading fundamental and applied science on the patented Ultra-nanocrystalline diamond (UNCD) film technology developed over the last 14 years opening the door to a new era for diamond applications. In general, diamond deposition yields high-performance, long-lasting, radiation-hard dielectric films that can be thin or thick, can be etched alongside silicon components and can only be doped p-type. Diamond's stiffness yields faster resonators, its smoothness yields friction-free microelectromechanical systems and its chemical inertness makes it ideal for bioengineered devices such as human implants. UNCD is not a diamond-like carbon material, but a crystalline diamond film consisting of nano-sized grains. Such films, composed of 3-5 nm randomly oriented crystallites surrounded by 0.2-0.3 nm wide grain boundaries are highly electrically insulating unless doped with boron.

A new approach for preparing n-type conductive UNCD films has been developed. This approach entails MWPCVD based synthesis of UNCD from $CH_4/Ar/N_2$ mixture with high nitrogen content. The progressive substitution of nitrogen for argon in the synthesis gas renders the films increasingly electrically conducting with conductivities reaching several hundreds S/cm for 20 % by volume of added N_2. Hall effect measurements have determined the carriers to be n-type with concentrations of 10^{19} - $10^{21}/cm^3$ and mobilities of several $cm^2V^{-1}s^{-1}$.

The films can be considered insulators in the absence of added N_2, become semiconductors for modest N_2 additions and finally display metal-like behavior at the highest N_2 contents. This enables the controlled variation of synthesis conditions so as to produce ambiently conducting n-type diamond films showing the entire range from insulating to semiconducting and even metallic behavior. Moreover the conductivity changes are accompanied by a changeover from strong to weak temperature dependence suggesting that a transition from semiconducting hopping conductivity (0-5 % nitrogen) to metallic conductivity (5-20 % nitrogen) occurs in this regime. Surprisingly, the transition takes place over a variation of plasma nitrogen content of only a few percent. These films are clearly of scientific interest but are also potentially useful since they provide the only currently available n-type diamond material that is electrically conducting at ambient temperatures. One already demonstrated application of UNCD is as part of a highly rectifying diode which is electrically stable even after repeated cycling to 1300K.

A close correlation between the film structure and the electrical conductivity of UNCD films has been observed. Large area, highly dense UNCD nanowires have been successfully synthesized on silicon substrates within substrate temperatures range of 800-900 C starting from 10% of nitrogen in the gas phase. The resultant diamond nanostructures were uniform wires which vary from 5 to 10 nanometers in diameter and between 80-100 nm in length. The transformation from randomly oriented 3-5nm diamond crystallites to diamond nanowires surrounded by a largely sp^2 bonded carbon sheath is followed in detail making use of the High Resolution Transmission Electron Microscope (HRTEM), Electron Energy Loss Spectroscopy (EELS), Scanning Electron Microscopy (SEM) as well as micro-Raman spectroscopy.

General views of the samples are displayed in Fig. 1 (I) and (II) corresponding to a SEM image and a low magnification plane view TEM micrograph, respectively. These images show the presence of elongated nanowires (NWs) embedded by a matrix composed by randomly oriented 3-5 nm crystallites of UNCD. The formation of these nanowires starts to appear when the N_2 content in the gas phase reaches about 10% in volume. Fig. 2 corresponds to a HRTEM micrograph of a NW showing the presence of the lattice fringes with a spacing of ~ 0.21 nm which correspond to the d-spacing of the (111) planes of diamond. The NWs are enveloped by an amorphous layer of about 1nm thick. This layer is likely formed during the growth of the NWs. The analysis of the fine structure by EELS confirms that each NW is diamond and that they are enveloped in a sheath of sp^2 bonded carbon.

From this study it can be concluded that the metal-insulator transition of these films is strongly correlated with the formation of these diamond NWs. These NWs are enveloped by an amorphous carbon layer that seems to provide the conductive path for electrons.

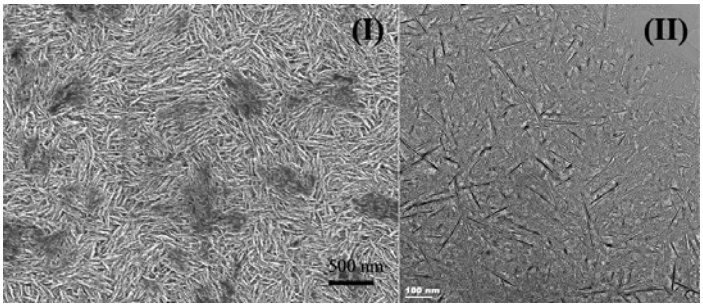

***Fig. 1**. (I) SEM and (II) low maginification TEM images of the samples showing the presence of NWs.*

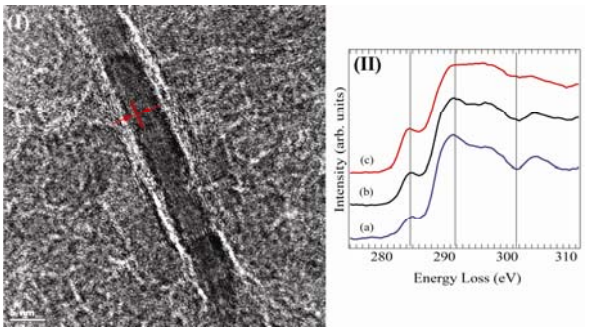

***Fig. 2. –(I)** HRTEM image showing one of these Diamond NWs and the matrix. The [111] diamond planes are visible (markers between arrows).*

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Contact: Dr Dieter Gruen (dmgruen@anl.gov)

New Centre for Micro/Nano Manufacturing Technology in Tianjin

Research Centre of Micro/Nano Manufacturing Technology (MNMT) was set up in Tianjin, China in December 2006. This is probably one of the first institutions concentrating on developing micro/nano manufacturing technologies for the industry. The research and development work carried out in the centre can be categorised in areas, such as ultra-precision machining of nanometric freeform surfaces, 5-axis machining of brittle materials, focused ion beam (FIB) fabrication for nano features, and micro/nano

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SOCIETY OF NANOSCIENCE AND NANOTECHNLOGY

www.nano-society.org

The Society of Nanoscience and Nanotechnology (SNN) is a worldwide organisation set up to serve the needs of the "nano" community. Currently, it is one of the very few organisations in the world that sets out to serve such a purpose on a global scale. SNN is designed to provide an effective and stimulating platform for world people to foster, develop and promote communication, education, networking, dissemination of knowledge, research and innovations in aspects of nanoscience and nanotechnology.

Aims and objectives:

- Promote all aspects of nanoscience and nanotechnology
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- Raise, discuss and debate nano-related issues, including government policies on nanotechnology
- Offer different levels of memberships, with benefits, to people working in nanoscience and nanotechnology.
- Organise and manage international nano-related conferences
- Provide an effective advertising platform for companies to promote their business
- Promote education and training through organising workshops, short educational courses, seminars, etc.
- Bringing to the front, current and most recent up-to-date scientific and technical information to the public
- Provide consultancy services to both people from academia and industry
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NANOAFFAIRS

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CONFERENCES FOR 2007 (ORGANISED/SUPPORTED BY SNN)

2nd International Conference on Surfaces, Coatings and Nanostructured Materials — Algarve, Portugal, 9-11 July

International Conference on Surfaces, Coatings and Nanostructured Materials (NanoSMat) is organised to enable knowledge exchange and also provide an interactive platform for researchers and engineers from industry, research laboratories and academia.

NanoSMat 2007 is the second of this series. Following its success as **NanoSMat-2005**, NanoSMat 2007 will bring together state-of-the-art developments on all aspects related to the processing, characterization and applications of surfaces, coatings and novel nanostructured materials.

A major aspect of the conference is to foster close collaborations among scientists, engineers, researchers and industrialists thus providing an opportunity to create links for future developments. The conference will provide ample opportunity for the conference delegates to network in a friendly and supportive environment.

NanoSMat07 will host an exhibition and offer several short educational courses relating to nanostructured materials, nanoscience and nanotechnology. For more details visit the NanoSMat homepage: www.nanosmat.org

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3rd International Conference on Diffusion in Solids and Liquids: Mass transfer, Heat transfer, Microstructure & Properties, Nano diffusion and Nanostructured Materials (DSL 2007)
4-6 July, Algarve, Portugal

For more information visit the DSL2007 webpage: **www.dsl2007-algarve.de**

Abstract submission deadline – **30 April 2007**

International Conference on Advanced Computational Engineering and Experimenting (ACE-X)
12-13 July 2007, Portugal

ACE-X provides a unique opportunity to exchange information, present the latest results as well as assess the relevant issues on computational and experimental research.

For more details visit the ACE-X webpage: www.ace-x.de

NEW BOOKS

Nanocomposite Thin Films and Coatings: Processing, Properties and Performance

Editors: Sam Zhang and Nasar Ali

Publishers: Imperial College Press, UK.

Publication date: Scheduled Fall 2007

Price: 124 USD or 67 GBP

More details: http://www.icpress.co.uk/nanosci/p502.html

Materials development has reached a point where it is difficult for a single material to satisfy the needs of sophisticated applications in the modern world. Nanocomposite films and coatings achieve much more than the simple addition of the constitutents — the law of summation fails to work in the nano-world. This book encompasses three major parts of the development of nanocomposite films and coatings: the first focuses on processing and properties, the second concentrates on mechanical performance, and the third deals with functional performance, including wide application areas ranging from mechanical cutting to solar energy and from electronics to medicine.

Readership: Undergraduates, postgraduates, researchers, scientists, college and university professors, research professionals, technology investors and developers, research enterprises, R&D research laboratories, academic and research libraries.