



**The Egyptian Materials Research Society
(Eg-MRS)**

In Cooperation with

**Misr University for Science & Technology
(MUST)**

Organizes
4th One-Day Seminar
On

*Nanostructure Science
In Solids and
Biological Systems*

Thursday, 27th December 2007

MUST, Sixth of October City

Program

9.30 - 10.00: Registration.
10.00 - 10.30: Opening and Introductory Remarks.

First Session: Fundamentals

Chairman: Raafat K. Wasef, Cairo University

- 10.30 - 11.10: Lecture (1): **“Dynamics at the Interface in Nanofilled Materials”**
Dr. Mohamed A. Sharf, Helwan University
- 11.10 - 11.50: Lecture (2): **“Exchange Bias and Magnetic Relaxation in Some Antiferromagnetic Nanoparticles”**
Dr. Salah Makhoulf, Assiut University
- 11.50 - 12.30: Lecture (3): **“Rule of Nano-silica coating for Performance Improvement of Cosmetics UV-Rays Absorbents”**
Dr. Ahmed El-Toni, CMRDI

12.30 -13.00: Break

Second Session: Applications

Chairman: Prof. Dr. Moustafa Kamel, MUST

- 13.00 - 13.40: Lecture (4): **“Nano-Scale Materials: Role in Tissue Engineering”**
Prof. Dr. Mona K. Marei, Alexandria University
- 13.40 - 14.20: Lecture (5): **“Advanced Sub-micro/nano-Materials for Detection of Biological Molecules and Drugs”**
Prof. Dr. Ahmed Galal, Cairo University.
- 14.20 - 15.00: Lecture (6): **“Nanotechnology and Drug Delivery”**
Dr. Amany Kamel, Ain Shams University

Abstracts are available on Website: www.egmrs.org.

15.00 -16.00: Lunch

16.00: Departure

L1: Dynamics at the Interface in Nanofilled Materials

Mohamed A. Sharaf

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A ^1H NMR method is described for examining crystallinity, chain mobility, and crystallite size in real-time during polymer crystallization. The method is demonstrated by following the crystallization of natural rubber at $-10\text{ }^\circ\text{C}$. At selected stages during the crystallization, a Bloch decay was recorded along with Goldman-Shen decays for a series of mixing times using a filter duration to destroy the rigid-phase magnetization. The fast-relaxing components of the Bloch and Goldman-Shen decays correspond to the rigid/crystalline fraction of the sample and were fitted to Gaussian functions. The slow-relaxing components were obtained experimentally using the Goldman-Shen sequence measured with a short mixing time (1 ms). Combining the fitted Gaussian portions with the experimentally determined slowrelaxing components provided a very robust methodology for analyzing the Bloch and Goldman-Shen decays. The Bloch decays provided information on the amount and mobility of the rigid fraction, while the Goldman-Shen spin-diffusion data provided information on domain size. The formation of non-crystalline rigid domains was observed for the initial stages of the crystallization process. Data clearly indicate lateral growth of crystallites with relatively uniform thickness during the primary crystallization process. Later stages of crystallization are characterized by increasing heterogeneity in crystalline density and order.

Also, a summary of our group's work on the synthesis and molecular modeling of nanocomposites will be presented. In addition, some of our results concerning novel synthesis of nanoporous silica and bioactive glass scaffolds and their utilization in tissue engineering applications will be addressed

L2:

Exchange Bias and Magnetic Relaxation in Some Antiferromagnetic Nanoparticles

Salah Makhlof

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Antiferromagnetic nanoparticles represent key constituents in structures showing the "exchange bias" effect and are used for magnetic field sensors such as magnetic tunnel junctions and spin valves. From basic science point of view, they are of considerable interest in their own. Clear understanding of the size-dependent properties of such nanoparticles will considerably contribute to optimize the performance of such devices.

The presentation focus is on the influence of the particle size and temperature on the Exchange bias in Co_3O_4 and NiO nanoparticle systems. For 20 nm size Co_3O_4 particles, exchange fields of several hundreds Oe are observed at low temperatures. Dependencies of the coercivity and the exchange field on both the temperature and the cooling magnetic field are studied and discussed. For NiO on the other hand, the particle size dependence of surface magnetization, coercivity and exchange bias effects in terms of an AF/FM core-shell structure has been done for the first time for this system. We have found that the largest value of the interfacial exchange energy is very close to that observed in NiO/Co and NiO/permalloy bilayers. Moreover, the coercivity enhancement was found to follow the change of interfacial exchange energy as the particle size changes.

The magnetic relaxation of 20 nm size Co_3O_4 and 5 nm size NiO particles is also discussed. Magnetization relaxes according to $M(t) = M(t_0) [1 - S(T) \ln((t+t_0)/\tau_0)]$. Temperature dependence of the magnetic viscosity $S(T)$ is thus determined in a wide temperature range. $S(T)$ for Co_3O_4 was temperature independent for $1.8K \leq T < 10K$, probably due to magnetic quantum tunneling, whereas it increases linearly with T in a limited range $8K < T < 20K$ due to thermal effects. Around 25K, $S(T)$ exhibits a very sharp maximum which indicates a phase transition. In NiO on the other hand and for $T < 20K$, $S(T)$ appears to extrapolate to about zero when $T=0$, as would be expected for decay of the magnetization via thermal activation.

L3: Rule of Nano-silica coating for Performance Improvement of Cosmetics UV-Rays Absorbents

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It is well known that ultraviolet (UV) rays cause sunburn and suntan. UV rays in sunlight are important factors which produce skin cancer. Recently, UV-rays absorbents products and their degree of efficacy and risks have been under investigation. The efficacy of UV-rays absorbents can be greatly improved by controlling their intrinsic properties via surface coating. In this study, performance improvement for organic and inorganic UV-rays absorbent through surface coating with nano-silica shell was performed.

This work focuses on silica coating of Zn₂Al-LDH/DASDSA to depress the deintercalation behavior of organic UV-rays absorbents from layered structure. The findings indicate that silica coating helps in decreasing the deintercalation of DASDSA from the layer structure. The sol-gel method is superior to acid hydrolysis of Na₂SiO₃ to obtain the sample uniformly coated with SiO₂. Spherical silica particles were precipitated on the surface of Zn₂Al-LDH/DASDSA.

Investigation was directed to control oxidation catalytic of CaO-doped ceria by silica coating. Characterization of CaO-doped ceria by TEM and FTIR indicates that silica shell was developed on CaO-doped ceria surface. XPS measurement suggests that Ce-O-Si bond was developed. The catalytic ability of CaO-doped ceria for air oxidation of castor oil was decreased substantially by coating with silica shell using sol-gel of TEOS and acid hydrolysis of Na₂SiO₃.

TiO₂ nanoparticles as famous conventional inorganic UV-rays absorbents cause photocatalytic degradation of organic molecules, especially when they are exposed to ultraviolet rays or sunlight. The covering of the titania surface with protective silica shell is a key point in its development for industrial application in cosmetics. Depression of high photocatalytic activity of titania necessitates that silica shell has to be thick with minimum microporosity. Titania nanoparticles were coated with amorphous silica by means of a sol-gel technique. TEM and EDX analyses showed that titania nanoparticles were homogeneously coated with an amorphous SiO₂ layer. Microporosity along with silica shell thickness affected greatly the photocatalytic activity of titania nanoparticles.

The results indicated that this study accomplishes its targets by enhancing performance of UV-rays absorbents through reducing their undesired properties without loss of their UV-rays shielding ability.

L4: Nano-Scale Materials: Role in Tissue Engineering

Mona K. Marei

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Tissue engineering scaffolds depend mainly on two important parameters which are: (1) the physical properties of the scaffolds, (2) the mechanical demands of the implantation site. Ideally scaffolds for tissue engineering should act as templates to direct cell growth and ECM formation, and to accomplish this, the scaffold materials must possess unique properties.

New technologies have always been a major driving force in medical device field. The emergence of micro- and nanoscale science and engineering has provided new avenues for engineering materials with macromolecular and even down to molecular-scale precision, leading to revolution in tissue engineering scaffolds materials. Biomaterials have evolved from off-the-shelf products (e.g., Dacron for vascular grafts) to materials that have been designed with molecular precision to exhibit the desired properties for a specific application, often mimicking biological systems. Controlling interactions at the level of natural building blocks, from proteins to cells, facilitates the novel exploration, manipulation, and application of living systems and biological phenomena. Nanostructured tissue scaffolds and biomaterials are being applied for improved tissue design, reconstruction, and reparative medicine.

Since nature itself exists in the nanometer regime, especially tissues in the human body, it is clear that nano-scale materials can play an integral role in tissue regeneration. Specifically, bone is composed of numerous nanostructures — like collagen and hydroxyapatite (HA) that, most importantly, provide a unique nanostructure for protein and bone cell interactions in the body. Although the ability to mimic constituent components of bone is novel in itself, there are additional reasons to consider nanoscale materials for tissue regeneration, as their special surface properties compared to conventional (or micron constituent component structured) materials. For example, a nanoscale material has increased numbers of atoms at the surface, grain boundaries or material defects at the surface, surface area, and altered electron distributions compared to conventional materials. In summary, nanophase material surfaces are more reactive than their conventional counterparts. In this light, it is clear that proteins which influence cell interactions that lead to tissue regeneration will be quite different on nanophase compared with conventional implant surfaces.

L5: Advanced Sub-micro/nano- Materials for Detection of Biological Molecules and Drugs

Ahmed Galal

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Conducting polymers are electrochemically polymerized at inert surfaces of glassy carbon, platinum or graphite. The conducting polymer films are modified by electrochemically depositing platinum particles. The technique of deposition depends on applying a programmed potential pulse at the polymer film from a solution containing platinum complex. The size of the platinum particles was controlled by the time interval of the pulse signal. The effect of changing the size of platinum particles and polymer film thickness on the voltammetric behavior of the resulting hybrid material showed noticeable change in the electro-catalytic current in sulfuric acid medium. On the other hand, the electrochemical impedance experiments at the same films proved that the diffusion and charge transfer differed significantly when comparing the polymer films with those containing platinum particles. The increase in diffusion and charge transfer rate increased in the order: unmodified polymer films, platinum-containing polymer films, thin polymer films containing average size platinum particles, and relatively thick polymer films containing average size platinum particles. The morphology of polymer films, size and distribution of platinum particles in the film were studied by scanning electron microscopy. The presence of platinum and its distribution over the film surface was confirmed from the X-ray dispersive analysis and surface mapping. The hybrid materials are good candidates for the application in energy conversion devices namely fuel cells. The second application of such polymeric surfaces is in the potentiometric analysis of some ionic species. Our current research efforts towards the modification of the polymer films with inorganic components to form a hybrid organic/inorganic composite with metallic particles in the sub-micro scale will be also presented. On the other hand, we used sol-gel matrices for the molecular recognition of amino-acids. We have been able to physically/electrostatically imprint the surface with the target molecule and successfully rebind it exclusively at the same surface. Sub-nanoscale templates are believed to form in this case that will be promising for chiral separation and amino-acid sequence analysis.

L6: Nanotechnology and Drug Delivery

Amany Osama Kamel

Department of Pharmaceutics, Faculty of Pharmacy, Ain Shams University

Nanomedicine is a science that uses nanotechnology to maintain and improve human health at the molecular scale. At present 95% of all new potential therapeutics have poor pharmacokinetics and biopharmaceutical properties. Therefore there is a need to develop suitable drug delivery systems that distribute the therapeutically active drug molecule only to the site of action without affecting healthy organs and tissue. Nanotechnology plays an important role in this. Current and potential applications of nanotechnology in medicine range from research involving diagnostic devices, drug delivery vehicles to enhanced gene therapy and tissue engineering procedures. Its advantage over conventional medicine lies on its size. Particle size has an effect on blood circulation life time and pattern of disposition. This allows drugs of nanosize be used in lower concentration and has an earlier onset of therapeutic action. It also provides materials for controlled drug delivery by directing carriers to specific location.

This lecture highlights possible application of nanotechnology in pharmaceutical products and the potential use of nanosystems in targeted drug delivery and how they may be employed to overcome some challenges in drug delivery.