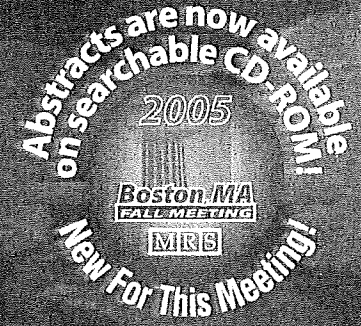
# 2005

# Boston, MA
## FALL MEETING

# MRS

**November 28 - December 2**
**Hynes Convention Center & Sheraton Boston Hotel**
**Boston, MA**




# ABSTRACTS

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application of these principles in nanoscience, I'll describe an approach to patterning nanometer-scale structures through a convenient, high-precision process. Our approach is based upon functional group-directed assembly of well-defined nanoparticle building blocks. I will focus primarily on our efforts to organize ligand-stabilized gold nanoparticles onto DNA templates to form extended 1- and 2-dimensional assemblies. One of the key features of scaffolding approaches that rely on DNA templates is the precision with which the 2- and 3-D structures can be controlled. In addition to particle size and interparticle spacing, the pattern and size of the assembly can also be controlled. The spacing between neighboring nanoparticles can be tuned at the molecular level by utilizing nanoparticles possessing ligand shells of varying thickness to achieve Angstrom-level resolution at spacings of 1.5, 2.1, and 2.8 nm. This "bottom-up" approach will be compared to more traditional "top-down" lithographies to assess the performance and waste production of the methods.

**11:00 AM S3.9**
**Inorganic Fullerene-like Nanospheres: New Superior Materials for Enhanced Lubrication.** Alla Zak[1], Yekimov Sergei[1], Niles Fleischer[1], Menachem Genut[1], Lev Rapoport[3] and Reshef Tenne[2]; [1]NanoMaterials, Ltd., Rehovot, Israel; [2]Weizmann Institute of Science, Rehovot, Israel; [3]Holon Academic Institute of Technology, Holon, Israel.

Inorganic fullerene-like (IF) nano-spheres IF-MS2 (M=Mo,W) are related to the conventional layered 2H-MS2 compounds. Our special synthesis method causes the layers of such lamellar compounds to curve into concentric nested nano-sized spheres. The fortunate combination of a multi-walled onion-like structure, small size and chemically inert surface of nano-spheres provides these materials with a unique set of chemical and physical properties. Work done to obtain a better understanding of the growth mechanism of IF-MS2 nanoparticles has now resulted in our successful scale up of the IF synthesis to commercial quantities. Starting from 0.4g/batch, our new reactor design now enables us to produce up to 1000 g/batch. These new materials can be used as solid lubricants to significantly reduce friction and wear under a variety of extreme conditions of load, humidity, and ultra-high vacuum. Tribological tests show that IF appreciably outperforms the conventional 2H phase of the same compounds in friction, wear and longevity under different contact conditions. By using of IF instead of 2H phase the friction coefficient was decreased by up to 50 to 75% and wear by over an order of magnitude, depending on the application. Comparison tests of IF and 2H were done by 1) mixing the powders with oil or grease, 2) impregnating them into porous sintered materials such as bronze-graphite and Fe-Ni-Graphite, and 3) applying them as an anti-friction coating. In the case of greases and oils, the nano-sized IF particles provided appreciably better lubricating properties compared to the conventional 2H phase of the same MS2 compounds, even when the 2H powders were sub-micron in size. This can be at least partially explained by the higher strength and greater chemical stability of the IF nano-spheres. In contrast to the spherical IF, the 2H phase has a lamellar structure with reactive dangling bonds on their crystalline edges. In addition, during use the 2H particles may not always be aligned parallel to the friction surface while the symmetrical nature of the IF nano-spheres allows them to always be suitably oriented with regards to the contact surfaces. In the case of impregnation, the above mentioned properties of nano-size spherical solid lubricant IF-nanoparticles enable them to be gradually furnished to the rubbed surfaces from within the pores by unique self-lubricating mechanism. The synthesis of WO3 powder deserves particular attention since it serves as a precursor for IF production. One of the most important conditions needed in order to synthesize spherical, nano-sized IF is that the precursor WO3 powder should also be nano-sized and of spherical shape. A unique process for synthesis of WO3 particles 30-300nm in diameter of spherical shape with 100% product yield was developed in our labs.

**11:15 AM S3.10**
**Characterization of Carbon Nanotube Purity Using a Quartz Sensor Platform.** Stephanie Anne Hooker[1], Ryan Schilt[1], Natalia Varaksa[1], John Lehman[1] and Paul Rice[1,2]; [1]Materials Reliability, NIST, Boulder, Colorado; [2]Department of Mechanical Engineering, University of Colorado, Boulder, Colorado.

Carbon nanotubes are revolutionary materials, with properties that are vastly different than any other bulk form of carbon. Their unique combination of electrical, mechanical, and thermal properties makes them attractive for applications in advanced structures, biomedical devices, and next-generation electronics, among many others. However, properties can differ considerably depending on certain material characteristics (e.g., diameter and chirality). The situation is further complicated by the fact that most routes for nanotube growth do not produce just one species, but instead generate a mixture along with chemical impurities. As a result, nanotube characterization remains a critical issue for manufacturers, product developers, regulatory agencies, and biologists investigating health and safety risks. Currently, multiple separate analytical instruments are needed to measure purity, including a combination of thermogravimetric analysis (TGA), near-IR adsorption spectroscopy, X-ray diffraction, Raman spectroscopy, X-ray photoelectron spectroscopy, and electron microscopy. These techniques provide complementary data on chemistry and structure. However, separate specimens are typically required for each, raising concerns as to whether these individual data points adequately represent the characteristics of an entire batch. This paper describes a new platform for rapidly assessing tube quality that interrogates a single specimen. The approach utilizes an acoustic wave sensor based on a thin quartz crystal as the primary measurement apparatus on which electrical, thermal, optical, and thermo-chemical properties can be simultaneously measured. For concept demonstration, we observed the thermal purification of multi-walled nanotubes by removing the non-nanotube carbons by heating in an oxygen-containing atmosphere. We first dispersed the tubes in various liquids, including toluene, dimethyl formamide (DMF), and de-ionized water, and then applied thin coatings to the crystals by drop casting, spin coating, spray deposition, and dip coating. The crystals were externally heated from ambient to 500 C during which time the resonant frequency (4 MHz for the bare crystal) was monitored as a function of temperature using an impedance analyzer. Appreciable shifts in frequency, impedance, and phase were observed during heating, all directly attributed to mass loss. AC conductivity was also monitored during heating by means of a second electrode placed over the nanotube coating. These measurements revealed relatively high resistance for the as-received nanotubes, with conductivity increasing during purification. Results confirm that the acoustic resonances of quartz crystals can be used to characterize nanotubes. However, many measurement issues remain, including the effects of film thickness, deposition variability, crystal stability, and heat generation due to low-temperature catalyst oxidation. These challenges will be specifically discussed.

**11:30 AM S3.11**
**In-Flight Length Classification of Carbon Nanotubes by Gas-Phase Electrophoresis.** S. Kim and Michael R. Zachariah; University of Maryland and NIST, College Pak, Maryland.

We demonstrate the use of gas-phase electrophoresis to length classify CNTs grown in a continuous aerosol process. The separation process occurs at atmospheric pressure and involves electrostatic mobility separation which classifies fibers on the basis of equivalent projected surface area. This implies that one can for diameter controlled CNTs, obtain an on-the-fly determination of the CNT length distribution during CNT synthesis, or alternative y have a method to produce size separated CNTs. The method should be generic to any fiber based material.

**11:45 AM S3.12**
**Environmental Remediation Using Nanoporous Materials.** Tarek Abdel-Fattah, Department of Biology, Chemistry and Environmental Science, Chrisotpher Newport University, Newport News, VA.

Nanoporous materials characterized by well-defined pores in nanometer scale with unique molecular sieving capabilities and ultrahigh surface area are attractive to use as adsorbents for environmental remediation. We will discuss different synthesis strategies to produce effective adsorbents for environmental remediation. For example, we will present the use of organo-silicate nanocomposite materials for the remediation of chlorinated phenols from aqueous media. Also, we will present a study to support worldwide research efforts to obtain drinking water with arsenic levels below 10 part per billion (ppb) using different nanoporous adsorbents modified with different iron species. Furthermore, lead ions in soils and stormwater run-off from small arms firing range (SAFR) is a major concern. Various nanomaterials as adsorbents have been studied to remediate the problem of lead species releases to the environment. These nanomaterials can be used as barrier liners and point of use water treatment.

SESSION S4/G4: Joint Session: Nanomaterials: Biological and Environmental Interactions
Chairs: Vicki Stone and David Warheit
Tuesday Afternoon, November 29, 2005
Room 203 (Hynes)

**1:30 PM *S4.1/G4.1**
**Toxicological Profiles of Nanomaterials.** Erik Rushton, Gunter Oberdorster and Jacob Finkelstein; University of Rochester, Rochester, New York.

With the passage of the National Nanoscale Initiative in 2001 there has been increasing attention and funding given to nanomaterial