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3:15p.m.-4:15p.m.
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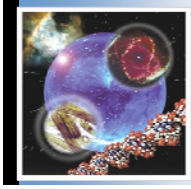
Science and Technology of Multifunctional Oxide and Ultrananocrystalline Diamond (UNCD) Films and Applications to a New Generation of Multifunctional Devices

Research and development on novel multifunctional oxide and nanocarbon thin films are providing the bases for new physics, new materials science and chemistry, and their impact in a new generation of multifunctional devices for energy generation, storage and saving, a new generation of high-density super-low energy consumption non-volatile memories, and a new generation of medical devices. This talk will focus on discussing a new paradigm in multifunctional oxide and novel ultrananocrystalline diamond UNCD) thin films and their integration, which is enabling devices as described below:

1. Science and technology of complex oxide thin films and technological applications: a) Novel TiO_2/Al_2O_3 superlattices, exhibiting giant dielectric constant (up to k=1000), low leakage current (10^{-7}-10^{-9} A/cm^2) and low losses (≤ tang d=0.04), based on new physics underlined by the Maxwell-Wagner relaxation mechanism, enable a new generation of energy storage microchip embedded capacitors for new electronics, including electronics implantable in the human body, the next generation of gates for nanoscale low energy consumption CMOS devices, and super-capacitors for energy storage systems; b) Novel transition metal oxide (TMO) films integrated into a new generation of super-low energy consumption non-volatile memories based on resistance change via quantum correlated electrons producing a metal-insulating Mott transition.

2. Science and technology of novel UNCD films and applications to macro. Micro, and nanotechnologies: UNCD films co-developed and patented by Prof. Auciello and colleagues are synthesized by a novel microwave plasma chemical vapor deposition technique using an Ar-rich/CH_4 chemistry that produces films with 2-5 nm grains, thus the name UNCD to distinguish them from nanocrystalline diamond films with 30-100 nm grains. The UNCD films exhibit a unique combination of outstanding mechanical, trtibological, electrical, thermal, and biological properties, which already resulted in industrial components and devices currently commercialized by Advanced Diamond Technologies (a company co-founded by O. Auciello and colleagues in 2003). Devices and systems reviewed include: a) UNCD-coated mechanical pump seals, providing up to 20% energy cost saving via friction reduction, for the petrochemical, pharmaceutical and car industries (**shipping to market**); b) UNCD-coated bearings for mixers for the pharmaceutical industry (**shipping to Merck-Millipore market**); c) new electrically conductive UNCD-coated metal electrodes for water purification system, which outperform all other electrodes in the market today **(shipping to market**); d) UNCD-based MEMS energy harvesting devices and biosensors; g) potential NEMS switch-based logic with lower energy consumption; e) New generation of Li-ion batteries and Thermal Li-Sulfur batteries with ≥ 10x longer life and reduced size, using UNCD-based coatings technology for new anodes, membranes and inner wall battery case chemically resistant coating; f) new generation of medical devices (e.g., artificial retina to restore partial sight to blind people, dental implants, hips, knees, and more) based on biocompatible UNCD coatings, which are in the process of being developed for commercialization through a second company (Original Biomedical Implants (OBI)) co-founded by Auciello and colleagues.



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