Tuesday Afternoon, October 29, 2013

Electronic Materials and Processing
Room: 102 A - Session EM-TuA

Evolution of Electronic Materials and the AVS
Moderator: S.M. Han, University of New Mexico, A.J. Muscat, University of Arizona

2:00pm **EM-TuA1 Division Chairs, Executive Committees and Perspectives on the Evolution of EMPD**, ***A. Rockett***, University of Illinois at Urbana Champaign **INVITED**

The Electronic Materials and Processing Division (EMPD) has been through a long evolution from a division driven heavily by the electronic device fabrication community to a division with less of a clear home. The plasma processing that is the core of the Plasma Science and Technology Division and nanotechnology that is central to the Nanoscience and Technology Division that now represent large fractions of the AVS program evolved from strong areas in the EMPD. The division now looks to organic and inorganic devices, oxides, metals, and many other less closely linked areas. As with several other divisions, the EMPD has had a strong intellectual connection to its topical conferences. However, unlike the other divisions, EMPD does not directly organize the three beams, molecular beam epitaxy workshop, physics and chemistry of surfaces and interfaces, and other topical conferences important to its core area. Although the senior members of the EMPD executive committee often have been senior organizers of these workshops, they run much more independently than do, for example, the ICMCTF and the Vacuum Technology Division or the ALD Workshop and the Thin Film Division. The leaders of the division over the years have struggled with the changes in the field and have worked hard to maintain the division as a vibrant part of the AVS. The EMPD looks forward to nucleating additional core areas of the AVS program in the future. It is truly the nursery for new AVS divisions and remains near the center of the AVS fields of interest.

2:40pm **EM-TuA3 Detonation Nanodiamond Particles for Electronic and Optical Applications**, ***G.E. McGuire***, International Technology Center, *O.A. Shenderova*, Adamas Nanotechnologies **INVITED**

Recent achievement of the production of colloidal suspensions of individual nanodiamond particles only 4-5nm in size (so called single-digit nanodiamond) and the controlled production of nitrogen-vacancy (NV) centers in nanoscale diamond has opened up unprecedented perspectives in electronic and optical applications of nanodiamonds (ND). Production of nanodiamond particles containing specific impurity defects seems poised to revolutionize biological imaging and quantum optics applications, while nanometer-sized diamond particles are indispensable for seeding of substrates for growth of diamond films by chemical vapor deposition (CVD). The range of applications of NDs in electronics can be very broad if electrically conductive ND particles can be synthesized. Production of conductive doped ND particles can be very beneficial in high surface area carbon electrodes for electroanalysis, electrochemical double-layer capacitors, storage materials for batteries and other applications. Nanodiamond-derived conductive onion-like carbon nanoparticles are already being explored in carbon electrodes applications.

The two major breakthroughs, the production of ND particles 4-5nm in size and ND particles containing impurity defects exhibiting stable luminescence and unique spin properties, are related to nanodiamond particles synthesized by two different techniques, detonation of explosives and breakdown of diamond produced through the use of high pressure-high temperature techniques, correspondingly. Owing to the lack of optically active particles containing NV centers in useful amounts, ND synthesized from explosives has not historically been amongst the preferred candidates for imaging applications. In this presentation the nitrogen content of NDs produced by several representative classes of synthesis including detonation shock wave conversion of different carbon precursor materials, detonation of a graphite\hexogen mixture, as well as different combinations of explosives using different cooling methods (wet or dry cooling) will be discussed. Perspectives for the production of photoluminescent NDs as a result of the generation of NV centers will be summarized. Photoluminescent carbon dot decorated ND, produced from a mixture of graphitic carbon and ND demonstrating surprisingly strong photoluminescence of different colors, will be described. Recent advances of ND applications, particularly in seeding of substrates for chemical vapor deposition diamond growth, will be surveyed and areas of future scientific research highlighted.

4:00pm **EM-TuA7 High Efficiency, Durable Quantum-Dot Hybrid Light-Emitting Diodes**, ***P. Holloway***, University of Florida, *Y. Zheng, L. Qian, Y. Yang, A. Titov, J. Hyvonen*, NanoPhotonica, *W. Cao, J. Xue*, University of Florida **INVITED**

Colloidal quantum-dot based hybrid light-emitting diodes (QD-LEDs) that exhibit record high efficiencies, long lifetimes, solution processability, color tunability and narrow emission bandwidths are reported. The devices exhibit world record quantum dot current and power efficiency of 3.2 cd/A and 2.1 lm/W for blue (B), 60 cd/A and 54 lm/W for green (G), and 15 cd/Aand 18 lm/W for red (R) emission. With exceptional good lifetimes, these QD-LEDs are extremely promising for flat panel display applications. The record efficiencies result from the use of a polymer hole transport layer (HTL) and a zinc oxide nanoparticles electron transport layer (ETL) sandwiching the quantum dot emitting layer (EML). The size and composition of the QDs were controlled during the synthesis process to emit at B, G or R wavelengths. We report all-inorganic QD-LEDs by using either vacuum deposited or solution processed MoO_3 as the HTL. Improved device performance can be achieved by engineering the interface between the hole injection and QD layers, as will be described.

4:40pm **EM-TuA9 Semiconductor Heterojunctions: The Revolutionary Breakthrough that Enabled the Photonic and High-speed Device Industry**, ***J. Woodall***, University of California, Davis **INVITED**

Most people on the planet have some form of a personal electronic device. Most professional scientists and engineers know that all of these devices were enabled by integrated circuit (IC) based "chips" that employ silicon (Si) field effect transistor (FET) technology. Currently the worldwide Si chip market is well in excess of $300 billion. One would not get an argument from someone who might claim that other than the airplane, Si chips were probably the single most revolutionary life-style changing breakthrough of the 20th century.

Important as this breakthrough was, it was limited to cost effective electronic devices and photo-detector ICs. However, only 7 years after the invention of the IC, another revolution was in the making: the invention of the lattice matched compound semiconductor heterojunction in 1967. This invention eventually morphed into, for example, injection lasers than enabled optical fiber communication, CD and DVD technology; high brightness and high efficiency visible (including white) LEDs that have enabled a photonic device industry that supplements the Si electronics industry. Furthermore, the heterojunction is employed in high speed, high power microwave devices that enabled cell phones and other remote wireless communication devices, e.g. i-phones, etc.

In this presentation the author will present a medium altitude review of how heterojunctions came about and why they do what they do.

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