INTERNATIONAL CONFERENCE ON METALLURGICAL COATINGS AND THIN FILMS

PROGRAM AND ABSTRACTS

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Sponsored by:
Advanced Surface Engineering Division
of AVS

Carbon and Nitride Materials
Room: Sunrise - Session D1-2

Carbon Nitride, Boron Nitride and Group-III (Al, Ga, In) Nitride Materials

Moderator: S. Gwo, National Tsing-Hua University, S. Ulrich, Forschungszentrum Karlsruhe

8:30am **D1-2-1 Field Emission from Oriented AlN Thin Films Fabricated by Reactive Magnetron Sputtering**, ***A.P. Huang***, *P.K. Chu (paul.chu@cityu.edu.hk)*, City University of Hong Kong, PR China

Nitrides have stimulated extensive research interest due to their applications in optoelectronic devices and field emitters in recent years. Among them, aluminum nitride (AlN), an important wide band-gap semiconductor material, turns out to be a very promising candidate as a field emitter because of its very small or even negative electron affinity, high mechanical stability, high thermal conductivity, and long-term stability in harsh environment. Such a small or negative electron affinity means that an electron can be extracted from the surface easily when an electric field is applied, which results in a large field-emission current density. Recently, a variety of techniques such as radio-frequency and magnetron sputtering, spray pyrolysis, chemical vapor deposition (CVD), sol-gel process, pulse laser deposition (PLD) and so on have been explored to fabricate AlN thin films. The field emission properties of AlN nanostructures including nanotubes and nanowires have also been reported. However, there have been very few investigations on the field emission properties of oriented AlN thin films. In this work, AlN thin films were prepared with the (100) and (002) orientations by reactive magnetron sputtering, and the influence of the orientation and thickness on the field emission properties were investigated. Our results reveal that the preferential orientation of (002) is beneficial to field emission. Besides, as the thickness of the thin film decreases, the field-emission current density increases, and at a thickness of 400 nm, the current density reaches 28.6/cm^2 and the turn-on field is close to 5 V/m. Our study suggests that oriented AlN thin films are potentially useful in field-emission-based displays and this paper also describes the underlying mechanism.

8:50am **D1-2-2 A Heating and Diffusion Barrier Based on $TaSiN_x$ for Miniaturized IC Devices**, ***H.-Y. Cheng***, National Tsing Hua University, Taiwan, *Y.-C. Chen, C.-M. Lee*, Industrial Technology Research Institute, Taiwan, *S.-H. Wang, T.-S. Chin (tschin@mx.nthu.edu.tw)*, National Tsing Hua University, Taiwan

The simulation using a one-dimensional heat conduction model shows that by inserting a high resistive heating layer (~10 nm thick) between the bottom electrode and phase-change layer will successfully decrease the operation current of a phase- change random-access memory (PCRAM) devices. Highly resistive $TaSiN_x$ films were investigated as candidates of such a heating layer. They were deposited by RF sputtering with $TaSi_2$ single target at an atmosphere of Ar+N_2 with different ratios of N_2 to Ar. The obtained resistivity, between 0.069 ~1.21 Ω-cm, fulfills the requirements as suitable heating layer suggested by simulations (0.01~1 Ω-cm) with increasing nitrogen content in films up to 52.83 %. All the as-deposited films were amorphous, while nitrogen-free Ta-Si films crystallized at 700°C, all other compositions with substantial nitrogen contents showed excellent thermal stability with amorphous structure sustaining until at least 800°C and exhibited very smooth surface examined by AFM. Besides the heating capability its amorphous structure being lack of grain boundary was found to perform a good diffusion barrier as well between W bottom electrode and $Ge_2Sb_2Te_5$ phase change films as determined by Auger analysis. The barrier effect was evaluated for an annealing at 400 and 500°C in Ar atmosphere for 30 minutes. The highly resistive $TaSiN_x$ heating layer successfully obstructed the diffusion of tungsten atoms from the W bottom electrodes into $Ge_2Sb_2Te_5$ phase-change films even if only quite a thin $TaSiN_x$ film of 10 nm inserted between them. With increasing N content, the barrier effect became more significant. Optimal composition of $TaSiN_x$ films as a diffusion/barrier layer for PCRAM was proposed.

Carbon and Nitride Materials
Room: Sunrise - Session D4

Frontier Devices for Bio, Energy- and Optoelectronic-Applications Based on Carbon and Nitride Materials

Moderator: B. Stoner, RTI International, P. Papakonstantinou, University of Ulster

9:10am **D4-3 Carbon-Nanotube Based Electrochemical Sensors**, ***J. Wang*** *(joseph.wang@asu.edu)*, Arizona State University **INVITED**

The unique chemical and physical properties of carbon-nanotubes (CNT) have paved the way to new and improved sensing devices, in general, and electrochemical biosensors, in particular. CNT-based electrochemical transducers offer substantial improvements in the performance of amperometric enzyme electrodes, immunosensors and nucleic-acid sensing devices. The greatly enhanced electrochemical reactivity of hydrogen peroxide and NADH at CNT-modified electrodes makes these nanomaterials extremely attractive for numerous oxidase- and dehydrogenase-based amperometric biosensors. This presentation will cover recent advances in the use of CNT for electrochemical biosensors, including novel designs of CNT-based electrical transducers and hybrid layers, and devices ranging from enzyme electrodes to DNA sensors.

9:50am **D4-5 Biofunctionalization of Diamond for Cell Growth and Bio-Sensing**, ***K.P. Loh*** *(chmlohkp@nus.edu.sg)*, National University of Singapore **INVITED**

Boron-doped diamond can be used as a signal transducer for biomolecules because of its wide electrochemical potentianl window and chemical stability. In this work, we discussed the chemistry of biofunctionalization used for making biosensors and surface electronics devices on diamond. Cycloaddition chemistry, electrochemical polymerisation, as well as UV-excited photochemistry of organic molecules on diamond will be discussed based on the results from core level spectroscopy and HREELS experiments carried out in our laboratory. Results of the electrochemical impedance sensing of linear, circular DNA and G-quadruplex on diamond electrodes will be presented. We also showed results on the growth and activation of cells on bio-functionalised diamond.

10:30am **D4-7 Luminescence and Impedance Spectroscopic Studies of GaN Nanowires with Immobilized DNA**, *C-P. Chen, A. Ganguly,* ***L.-C. Chen*** *(chenlc@ccms.ntu.edu.tw)*, National Taiwan University, Taiwan, *K.-H. Chen*, IAMS, Academia Sinica, Taiwan

Optical detection techniques are usually employed in commercially available state-of-the-art DNA micro-arrays, wherein the target molecules are labeled with fluorescence or chemoluminescence marker molecules. While electronic solutions offer promising opportunities in system miniaturization, improved ease-of-use and reduced cost for biosensors, development in this type of biosensors is still in its infant stage as compared to their optical counterparts. In this paper surface functionalization of the GaN nanowires that allows immobilization of the DNA and studies of their sensor response by both optical and electrochemical impedance techniques will be reported. GaN nanowires were prepared by catalytic chemical vapor deposition. These nanostructures are single crystals of nearly defect-free quality, as manifested by extremely sharp band edge photoluminescence (PL) emissions and weaker PL quenching in comparison to their thin-film counterparts. The one dimensional form of this nanomaterial not only leads to higher emission efficiency but also enables a path for electrical detection with sensitivity potentially higher than that achievable by its thin film counterpart. Moreover, it is observed that GaN nanowires changed from hydrophobic to hydrophilic upon surface oxidation, which in turn is an effective intermediate step to immobilize DNA. Both PL and impedance spectroscopic measurements revealed significant signal changes from the unmodified to modified nanowires with single-strand or double-strand DNA. Thus the applicability of the GaN nanowires as dual-function biosensors is demonstrated.