In-Situ Spectroscopy and Microscopy Focus Topic
Room: Hall D - Session IS-ThP

In-Situ Spectroscopy and Microscopy Poster Session

IS-ThP1 *In Situ* Synchrotron Radiation Photoemission Spectroscopy Study of Property Variation of Ta_2O_5 Film during the Atomic Layer Deposition, ***SeungYoub Lee**,* Sungkyunkwan University, Republic of Korea, *C. Jeon,* Korea Basic Science Institute, Republic of Korea*, Y. Kim*, Sungkyunkwan University, Republic of Korea*, J. Lee,* Korea Basic Science Institute, Republic of Korea, *C.-Y. Park*, Sungkyunkwan University, Republic of Korea

Atomic layer deposition (ALD) can be regarded as a special variation of the chemical vapor deposition method for reducing film thickness. ALD is based on sequential self-limiting reactions from the gas phase to produce thin films and over-layers in the nanometer scale with perfect conformality and process controllability. These characteristics make ALD an important film deposition technique for nanoelectronics. Tantalum pentoxide (Ta_2O_5) has a number of applications in optics and electronics due to its superior properties, such as thermal and chemical stability, high refractive index (>2.0), low absorption in near-UV to IR regions, and high-k. In particular, the dielectric constant of amorphous Ta_2O_5 is typically close to 25. Accordingly, Ta_2O_5 has been extensively studied in various electronics such as metal oxide semiconductor field-effect transistors (FET), organic FET, dynamic random access memories (RAM), resistance RAM, etc.

In this experiment, the variations of chemical and interfacial state during the growth of Ta_2O_5 films on the Si substrate by ALD was investigated using *in-situ* synchrotron radiation photoemission spectroscopy. A newly synthesized liquid precursor $Ta(N^tBu)(dmamp)_2Me$ was used as the metal precursor, with Ar as a purging gas and H_2O as the oxidant source. The core-level spectra of Si 2p, Ta 4f, and O 1s revealed that Ta suboxide and Si dioxide were formed at the initial stages of Ta_2O_5 growth. However, the Ta suboxide states almost disappeared as the ALD cycles progressed. Consequently, the Ta^{5+} state, which corresponds with the stoichiometric Ta_2O_5, only appeared after 4.0 cycles. Additionally, tantalum silicide was not detected at the interfacial states between Ta_2O_5 and Si. The measured valence band offset value between Ta_2O_5 and the Si substrate was 3.08 eV after 2.5 cycles.

IS-ThP2 Application of LEEM, PEEM and STM/ncAFM Techniques to Graphene on Metal Surfaces, *A. Thissen, **Violeta Simic-Milosevic***, SPECS Surface Nano Analysis GmbH, Germany

Abstract Summary: We present recently obtained results in graphene-based systems as measured with LEEM / PEEM and STM / NC-AFM techniques. We highlight the latest state-of-the-art developments in these two techniques and show how these techniques are applied in the latest graphene research as well in other experimental systems.

Introduction: Eighty years ago, Ernst Brueche developed the first photoemission electron microscope (PEEM) in the AEG laboratories in Berlin. Today, the state-of-the-art Low Energy Electron Microscope (LEEM) is produced just a few kilometers away from Brueche's former laboratory carrying forward this groundbreaking developments into the SPECS FE-LEEM P90. This instrument - based on the sophisticated electron-optical design by Ruud Tromp - combines user friendly operation with highest stability and ultimate resolution measurements. Graphene monolayer step edges on Si-sublimated SiC measured using the aberration corrector show a spatial resolution of 1.6 nm, closely approaching theoretical limits.

One of the advantages of SPECS systems is their interconnectability, in this case, by combining the LEEM / PEEM with a SPECS SPM Aarhus 150 with KolibriSensor. The SPM is an ideal system for investigating lattice mismatched surfaces, with a focus in the present talk of SPM measurements on the graphene/Ir(111) system. Microscopy experiments were performed in constant current / constant frequency shift (CC/CFS) and constant height (CH) modes, exploiting a combination of the STM and NC-AFM capabilities of the system. We found that in STM imaging the electronic contribution is prevailing compared to the topographic one and the inversion of the contrast can be assigned to the particular features in the electronic structure of graphene on Ir(111). Contrast changes observed in constant height AFM measurements are analyzed on the basis of the energy, force, and frequency shift curves, obtained in DFT calculations, reflecting the interaction of the W-tip with the surface and are attributed to the difference in the height and the different interaction strength for high-symmetry cites within the moirè unit cell of graphene on Ir(111).The presented findings are of general importance for the understanding of the properties of the lattice-mismatched graphene/metal systems especially with regard to possible applications as templates for molecules or clusters.

IS-ThP3 Quantum Cascade Laser Cavity Ring Down Spectroscopy: New Method for the Characterization and Detection of Aerosols, *E.M. Durke*, ***Angela Buonaugurio****,* Excet, Inc./Edgewood Chemical Biological Center, *J.M. Edmonds*, Edgewood Chemical Biological Center

Aerosolized chemical warfare agents (CWAs) and toxic industrial chemicals (TICs) are potential threats for the warfighter, resulting in the need for aerosol identification and detection for further developments in protection and mitigation. One of the most reliable techniques for the identification of trace gas species is absorption spectroscopy. Cavity ring down spectroscopy (CRDS) is a highly sensitive and selective absorption method with the ability to detect trace levels of chemical species. Its advantage is based on the extremely long effective path length, providing precise detection of the rate of decay of light from a high finesse optical cavity to directly measure the absorption of the trace gas. The mid-wave (MWIR) and long-wave (LWIR) infrared regions are of particular interest due to the characteristic rotovibrational absorption bands exhibited in these regions for identification of a species. Quantum cascade lasers (QCLs) have the capability of emitting both infrared wavelength regions, of 3-8 µm and 8-15 µm, respectively. During the first year of this multi year effort, we have developed a new method for the characterization of aerosols by combining the highly powerful spectroscopic method of cavity ring down spectroscopy and the ability to detect in the IR fingerprint region using quantum cascade lasers for identification. This novel technique results in in-situ investigations of chemical aerosols. The development of this method and preliminary data on accepted test vapors and simulants, leading up to aerosols of chemical warfare agents, are presented.

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