Facility Update

MAXPEEM – gearing up

MAXPEEM beamline on 1.5 GeV ring is approaching commissioning stage. The beamline is housing the most advanced low energy electron microscope with an aberration corrector. This AC-SPELEEM will be one of the best facilities in the world and will offer unique possibilities for extracting simultaneously elemental, chemical, magnetic and electronic information at spatial resolutions down to the 2-3 nanometer range to users from a wide area of research fields. So far the microscope is up and running off-line and has a great deal of interesting projects. One of them is a European TAILSPIN project where MAX IV is one of the main participants.

One of the ways to use graphene in field effect transistors is to introduce a band gap by quantum confinement effect. That is why narrow graphene nanoribbons (GNRs) with width less than 50nm are considered to be essential components in future graphene electronics. The growth of graphene on sidewalls of SiC(0001) mesa structures using scalable photolithography was shown to produce high quality GNR with excellent ballistic transport properties. Low energy electron microscope is a powerful tool to study such objects. We performed LEEM and micro-LEED studies on carefully grown GNRs and some of the LEEM results are highlighted in Figs. 1 and 2.

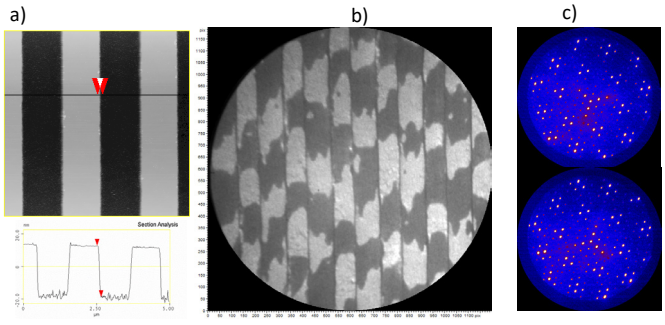

Fig.1. a) AFM image of the mesa structure after UV lithography; b) tilted bright field (TBF) (E=23eV) LEEM image showing a nice buffer layer on the top and bottom terraces (the mesa walls are dark vertical lines) with two domains from SiC after graphene growth, FoV=10mm; c) micro-LEED images from two domains in the TBF LEEM.

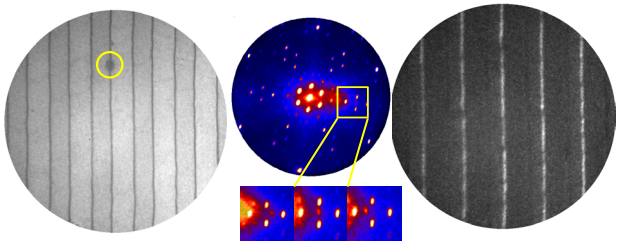

Fig.2 Bright field LEEM image (E=5eV; FoV=10mm), yellow circle marks the sampling area (250nm) for the micro-LEED from a single mesa wall; b) m-LEED pattern (E=25.5eV) from a single mesa wall. Insets (bottom raw) show a moving facet spot (electron energies are 25, 25.5 and 26eV, correspondingly) chosen for dark-field imaging; c) DF image (E=25.5eV) highlighting graphene nanoribbons on every second wall of the mesa structure.

HIPPIE – first year of operations

During first half of 2018 HIPPIE (soft x-ray beamline dedicated for APXPS) has provided 15 weeks of beamtime for scientific projects or commissioning of new functionality. Two new sample environments have been commissioned and made available for users: Electrochemical/Liquid (EC) cell and PM-IRRAS setup for simultaneous FTIR and XPS.

The EC cell is dedicated for operando studies of solid-liquid and liquid-gas interfaces of samples under full electrochemical control. Two sample environments could be used with this setup. With the the dip-and-pull method a solid sample is immersed inside the liquid electrolyte and consequently (partially) pulled out from it such that a thin layer of liquid remains on sample's surface also maintaining contact with the bulk electrolyte. In general, it is possible to find area on the sample where the thickness of the liquid film is only few nm, transparent for photoelectrons with few hundreds eV kinetic energy. This setup allows XPS measurements at the solid-liquid interface under equilibrium conditions (PH2O = 24 mbar @ RT) and full electrochemical control (counter and reference electrodes are included in the cell).

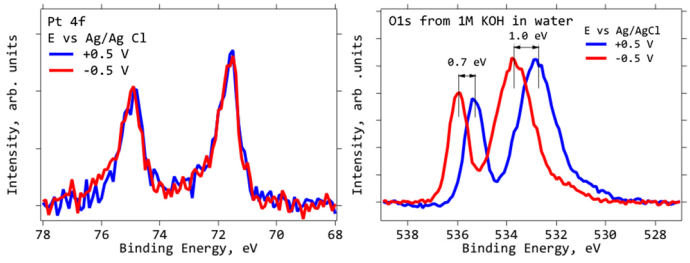

Figure 1. Pt 4f (left) and O 1s (right) XPS spectra from a 20 nm water layer on top of Pt foil. Different colors represent different applied potentials. Good overlap of Pt curves is due to grounding of the sample, whereas shift of water O1s indicates the potential is drop occurs strictly at the soli/liquid interface, thus no potential drop across the thin film.

Figure 1 shows Pt 4f photoemission spectra (left) from platinum foil used as a substrate and O1s spectra (right) originated from a thin liquid film of KOH on the surface of Pt. The thickness of the film estimated by the attenuation of Pt signal was 20 nm. Acquisition time for each spectrum is ca 1.5 minutes. Different colors of spectra correspond to different applied potentials. Good overlap of Pt4f spectra is due to grounding of the working electrode as required for XPS measurement, whereas shift of O1s spectrum originates from the difference in applied potential with the magnitude of the shift equal to the potential difference. The cell can also be equipped with a liquid microjet (15, 20 µm nozzle diameter) allowing XPS at the liquid-gas interface under equilibrium conditions.