ISSRNS 2010: Abstracts / Synchrotron Radiation in Natural Science Vol. 9, No. 1 – 2 (2010)

RECENT ACHIEVEMENT IN CHARACTERIZATION OF MICRO- AND NANO-MATERIALS BY SCANNING PHOTOEMISSION IMAGING AND SPECTROMICROSCOPY

Matteo Amati *, Majid Kazemian Abyaneh, Matteo Maria Dalmiglio, Luca Gregoratti, and Maya Kiskinova

Sincrotrone Trieste SCpA, SS14 Km163.5 in Area Science Park, 34149 Trieste, Italy

Keywords: electron spectroscopy, microscopy

**) e-mail: matteo.amati@elettra.trieste.it*

The Scanning PhotoEmission Microscope (SPEM) uses a direct approach to characterize chemically surfaces and interfaces at the submicron scale *i.e.* the use of a small focused x-ray photon probe to illuminate the sample. The focusing of the x-ray beam is performed by using a Zone Plate (ZP), which is a Fresnel type lens. The SPEM at the Elettra synchrotron light source, hosted at the ESCAmicroscopy beamline, can operate in two modes: imaging and spectroscopy. In the first mode the sample surface is mapped by synchronized-scanning the sample with respect to the focused photon beam and collecting photoelectrons with a selected kinetic energy. The second mode is an XPS from a microspot. The x-ray beam can be downsized to a diameter of 120 nm which allows imaging resolution of less than 50 nm. The overall energy resolution is better than 200 meV. Samples can be heated and biased during the measurements.

The beamline is open to the public and private research community; two call for proposals of experiment are available per year together with the possibility of dedicated collaborations on specific projects. Some recent achievements in the chemical, physical and electronic characterization of nano- and micro-structured materials will be presented providing an overview of the capabilities of this powerful technique. Metallic adsorbate interaction, oxidation and supporting properties of multiwall carbon, semiconducting and metal-based nanotubes will be presented, showing how even dynamic phenomena such as mass transport along the nanotube surface can be monitored by the SPEM [1,2]. A special design of the samples allows for the investigation of single nanotubes with diameter down to 50nm (see Fig. 1). The study of compositional and electronic properties of morphological complex 3D semiconducting structures will be presented as well.

Important industrial collaborations with international companies have been established in last years. A first example will report on the study of the degradation processes occurring on Organic Light Emitting Devices (OLEDs) [3]. Results on both OLEDs operated in ambient atmosphere and grown and operated in ultra-high-vacuum will be compared. Another example will illustrate the chemical characterization of the cathode surfaces of Solid Oxide Fuel Cells under working conditions [4]; the elemental distribution and its change under biasing and the observation and explanation of the cathode electrochemical activation have been addressed.

Finally an overview of the limits in the applications of the x-ray photoelectron microscopes imposed by the operation principles will be given together with the future developments allowing the investigation of materials at mbar and even ambient pressure.

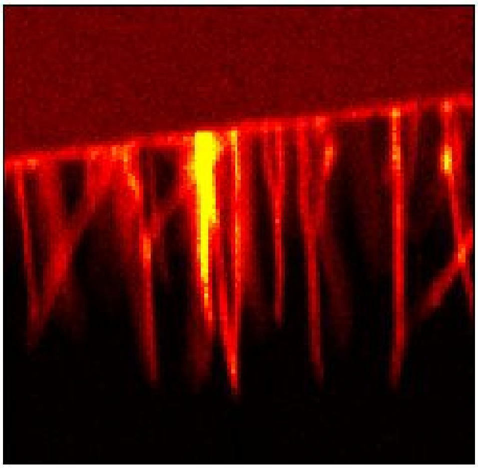

Figure 1. C1*s* photoemission map of aligned multiwall carbon nanotubes. Single separated tubes can be analysed.

References

[1] A. Barinov, L. Gregoratti, P. Dudin, S. La Rosa, M. Kiskinova, "Imaging and spectroscopy of multiwalled carbon nanotubes during oxidation: Defects and oxygen bonding", *Adv. Mater*. **21** (2009) 1916–1920.

[2] A. Barinov, H. Üstünel, S. Fabris, L. Gregoratti, L. Aballe, P. Dudin, S. Baroni, M. Kiskinova. "Defect-Controlled Transport properties of metallic atoms along carbon nanotube surfaces", *Phys. Rev. Lett*. **99** (2007) 046803.

[3] P. Melpignano, A. Baron-Toaldo, V. Biondo, S. Priante, R. Zamboni, M. Murgia, S. Caria, L. Gregoratti, A. Barinov, M. Kiskinova, "Mechanism of dark-spot degradation of organic light-emitting devices", *Appl. Phys. Lett.* **86** (2005) 041105.

[4] M. Backhaus-Ricoulta, K. Adib, T. St. Clair, B. Luerssen, L. Gregoratti, A. Barinov, "In-situ study of operating SOFC LSM/YSZ cathodes under polarization by photoelectron microscopy", *Solid State Ionics* **179** (2008) 891–895.