Surface Imaging and Spectromicroscopy Of Technological Materials: Complementarities Between Electron Spectroscopies, Scanning- and Ion Probes

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ABSTRACT

Engineering of surfaces and interfaces is a key step in the integration of technological materials, which must now be addressed at a local level. Surface-sensitive microscopies are therefore becoming increasingly important. However, within the wide landscape of advanced devices, from sub-32 nm transistors to micro-systems, the diversity of both scales and type of information to be addressed prevents from using a unique method being used in a reliable way. Thus, it is necessary to implement different techniques in a complementary way. Proximity and ultra-high vacuum environment are additional requirements for extracting reliable, cross-checkable information.

In this contribution, we will highlight the specificities of two state-of-the-art electron spectroscopy-based imaging techniques and their complementarities with scanning- and ion probes. These two methods, high-resolution XPS spectromicroscopy (XPEEM) and Nano-Scanning Auger Microscopy (SAM), have made recently significant progress in terms of lateral and energy resolution [1]. More specifically, XPEEM with laboratory X-ray sources now provides spectromicroscopic information from decananometric to mesoscopic scales [1,2], whereas novel Nano-SAM systems now offer Auger nano-analysis at high lateral (10 nm) and energy resolutions ($\Delta E/E$=0.1% and less). The complementarities will be presented in terms of (1) accessible lateral scales, (2) acquisition speed (scanning or full-field imaging modes) and (3) type of information available. Particularly we will highlight the capabilities of a characterization approach combining all these techniques in terms of multi-scale analysis. Selected examples will be given to illustrate this point, from the formation of SiC nanodots at silicon surfaces (Fig1, right) to graphene domains on SiC(0001) (Fig. 1, left) and sealing technologies for NEMS packaging.

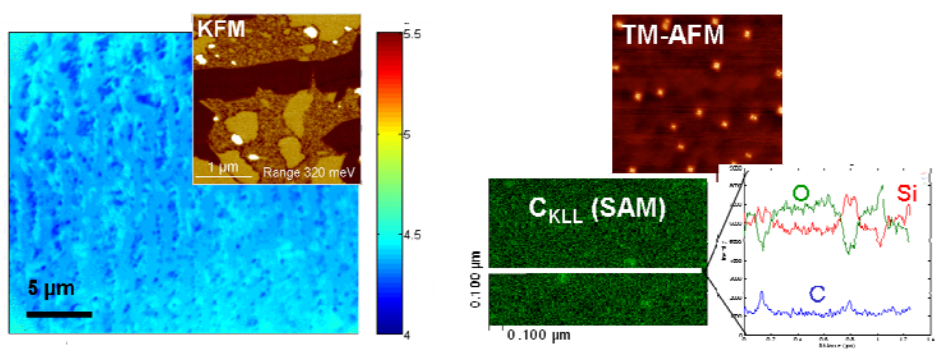

FIGURE 1. *Left:* Local work function maps by XPEEM and KFM of graphene domains on SiC(0001). *Right:* Nanodots identified by AFM at a silicon surface and corresponding analysis by nano-SAM.

Keywords: XPS spectromicroscopy, XPEEM, Auger mapping, SAM, work function, AFM, KFM, Tof-SIMS

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