New generation Auger nano-probes: a challenging tool for surface chemical analyses at localized scale

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Abstract

In recent years, Auger spectroscopy has been neglected on benefit of X-Ray photoelectron spectroscopy giving an easier access to the surface composition and chemical shift. Indeed, thanks to new generation electron sources, developed for high resolution microscopy, ultimate probe size of 10 nm is achieved with the new generation Auger nano-probes. Such equipments are therefore promising tools to address the need of localized chemical characterization of cutting edge structures whose dimensions are reaching the nanometric scale on which "classical" XPS (X-Ray source), with spot size of 400 to 30 microns, only permits to obtain global information. In addition, with energy resolution of 0.1 % (at 2000 eV), nano-Auger electron spectroscopy is not only able to give information about the composition but also, when the chemical shift is high enough, on the chemical environment.

The present work is dedicated to the determination of ultimate performances of nano-Auger spectroscopy. The lateral resolution is evaluated on a certified reference sample, BAM-L200 (« Bundesanstalt für Materialforschung und prüfung »), constituted of a stack of alternated lines of $Al_{0.7}Ga_{0.3}As/GaAs$ with variable intervals ranging from 700 to 7 nm. Results obtained with the different acquisition modes (point, line profile or mapping) will be presented (figure 1). Complementary AFM and XPS measurements will permit to extend the discussion about the impact of topography or surface oxidation state on the spatial resolution and on the detection limit. The capabilities of nano-Auger on practical cases are also presented. The question of the origin of the Auger signal with the topography of the sample and the geometry of electrons collection is approached on a textured Si wafer presenting Ni nuclei (figure 2). The accuracy of Auger quantification is tested on a SiGe multilayer sample[1] with Ge concentration varying within the cross section from 6 to 30% (X-Ray diffraction calibration) by 300-500 nm steps.

References

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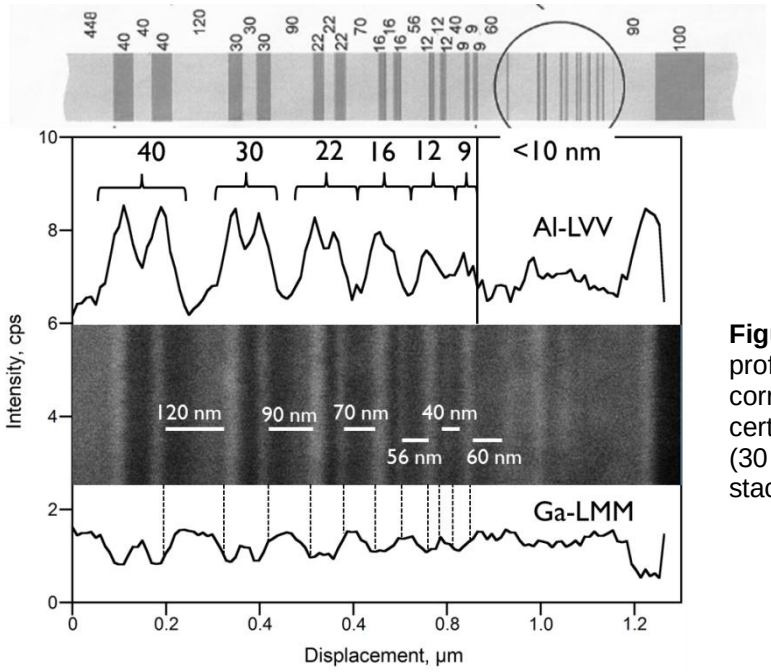

Figure 1. Al-LVV et Ga-LMM Auger line profiles and SEM image of the corresponding analysis area on a certified BAM-L200 reference sample (30 kV, 10 nA). The $Al_{0.7}Ga_{0.3}As$/GaAs stack is presented on top.

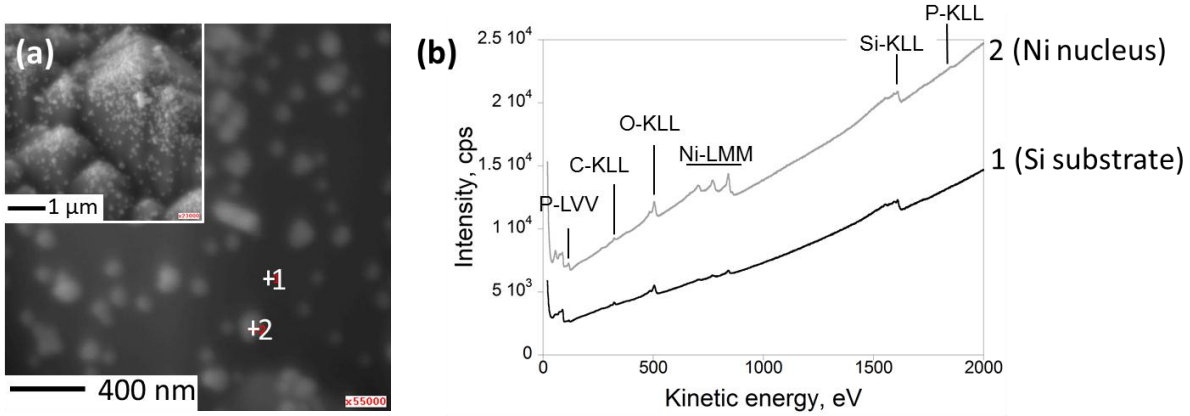

Figure 2. (a) Secondary electron image of a textured Si substrate after Ni nuclei deposition (b) Auger spectra acquired at the positions mentioned on (a) with a spot size of 20 nm (10 kV, 10 nA, dE/E = 0,5% at 2000 eV).