Secondary Ion Mass Spectrometry on the Helium Ion Microscope: High Sensitivity coupled with High Lateral Resolution

Audinot, J.[1], Vollnhals, F.[2], Gratia, P.[1], Eswara, S.[1], Philipp, P.[1] and Wirtz, T.[1]

[1] Luxembourg Institute of Science and Technology, Luxembourg, [2] Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

The Helium Ion Microscope (HIM) has become an ideal tool for imaging and nano-patterning [1]. Imaging with helium ions leads to resolutions of 0.5 nm for secondary electron (SE) based imaging, while structures with sub nm feature sizes may be rapidly patterned using Ne. Despite these advantages, the analysis capability of the instrument is limited. At beam energies of 35 keV helium or neon ions do not lead to the emission of characteristic X-rays from a sample. While some compositional information can be obtained from back scattered helium, identifying elemental information is more difficult. To add analytical capabilities to this microscope, we developed a specific SIMS spectrometer [2]. This new integrated HIM-SIMS instrument is capable of producing elemental chemical maps with sub-20 nm lateral resolution, thus approaching the physical resolution limits resulting from the dimensions of the collision cascades, while maintaining a sub-nanometric resolution in the secondary electron imaging mode [2].

With our system we started to perform HIM-SIMS analyses on broad categories of novel nanomaterials used for several applications related to micro-electronics, batteries, solar cells [3-4], coatings and developed in parallel different correlative strategies and methods to synergistically profit of both capabilities of the HIM-SIMS instrument, i.e. correlative imaging combining secondary electron imaging and secondary ion imaging [5], figure 1.

References :

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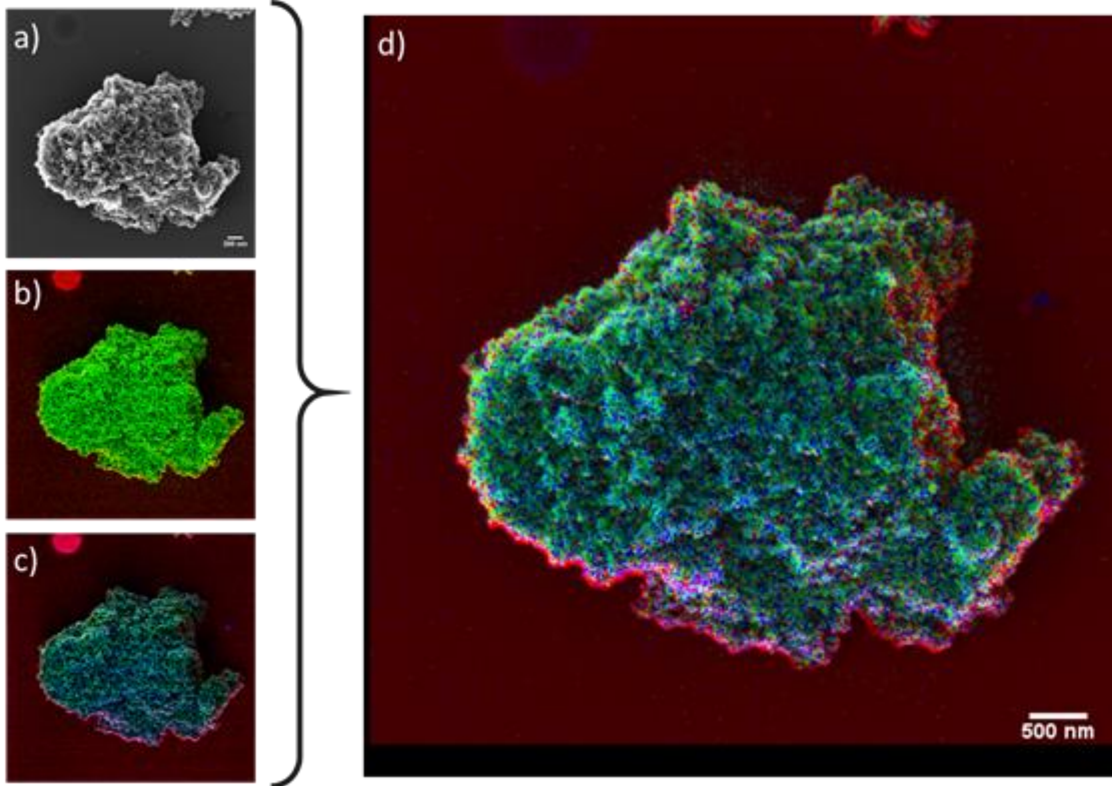

Figure 1 : Analysis of Titanium nanoparticules deposited on InP substrate. a) Secondary electron image. b) SIMS image of Ti (green) and In (red). c) SIMS image of Na (blue), Ti (green) and In (red). The secondary electron image was obtained with a 20 keV helium ion beam. The image size was 1024 x 1024 pixels. The SIMS images were acquired as a matrix of 512 x 512 pixels with a 20 keV neon ion beam, a primary current of 2 pA, and a counting time of 2 ms/pixel. d) Combined SIMS and SE imaging according to the methodology presented in [5]. Scale bar 500 nm.