Type of presentation: Poster

IT-14-P-2717 Integration of SPM module inside FIB-SEM instrument

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In the nanotechnology field, SPM (Scanning Probe Microscope) integrated into a SEM (Scanning Electron Microscope) offers a completely new opportunities [1]. Recently, TESCAN integrated a SPM with the lateral scan range up to 50 µm and Z scan range 8 µm [2]. Its compact construction is optimized for operating in a confined space of a FIB-SEM chamber without affecting the performance of both the electron or ion beams. Such dedicated SPM design allows the investigation of the same place on the sample by SPM, FIB (Focused Ion Beam) and high resolution SEM with a spot size down to 1 nm simultaneously without the need to perform an additional sample re-positioning.

We developed an intuitive software module to simplify the SPM navigation on the sample. It is possible to save the region of interest to a memory and recall it later on either by SPM, the SEM or both. Saved positions are shown along with their title in a live SEM window, see Fig. 1. The past experience has proved that the SPM module inside the FIB-SEM microscope is useful for several applications, such as process optimization of electron and ion beam lithography [3, 4] or TOF-SIMS (time-of-flight secondary ion mass spectroscopy) where the SPM can provide complementary information about the depth profile.

Fig. 2 shows an example how such a combination of the SEM, FIB and SPM was utilized. Hydrogenated Diamond-like Carbon (H:DLC) layer prepared by PECVD (Plasma Enhanced Chemical Vapor Deposition) method on a Si wafer was locally milled by FIB in order to uncover the Si-DLC interface, and the thickness of the DLC layer was measured using SPM. The damage caused by FIB milling is only local and it has no disturbing effects on measurements performed later on the same sample.

In another example we utilized in-situ cooperation of SEM/FIB/TOF-SIMS/SPM techniques together. FIB and TOF analyzer were used to create a concentration depth profile of elements contained in H:DLC layer deposited on an Si wafer, and the SPM navigated by the SEM provided an additional information about the true depth profile, see Fig. 3.

References:

[1] W Heichler, Microsc. Microanal. 19 (suppl. 2) (2013) p. 350.

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[4] J Jiruše et al, Proceedings 57th EIPBN (2013) p. 01-07.

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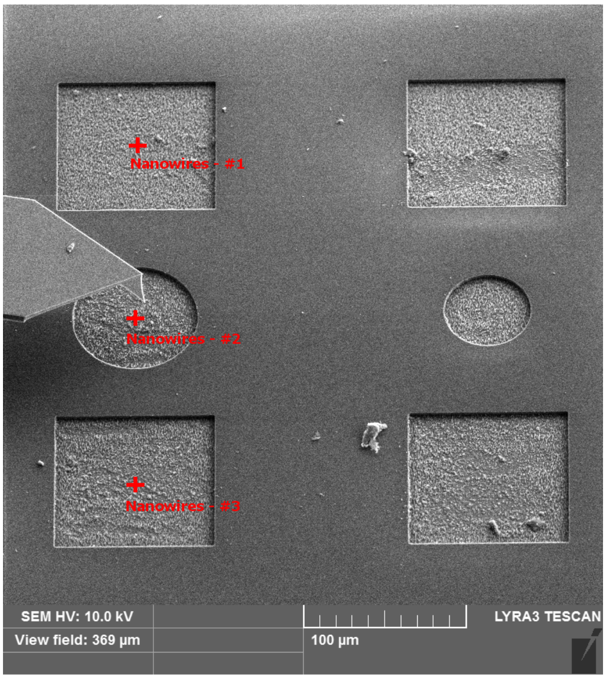

Fig. 1: Positions on the sample surface are saved to the memory and shown in a live SEM window. Position in a memory can be recalled either by SMP, SEM, or both.

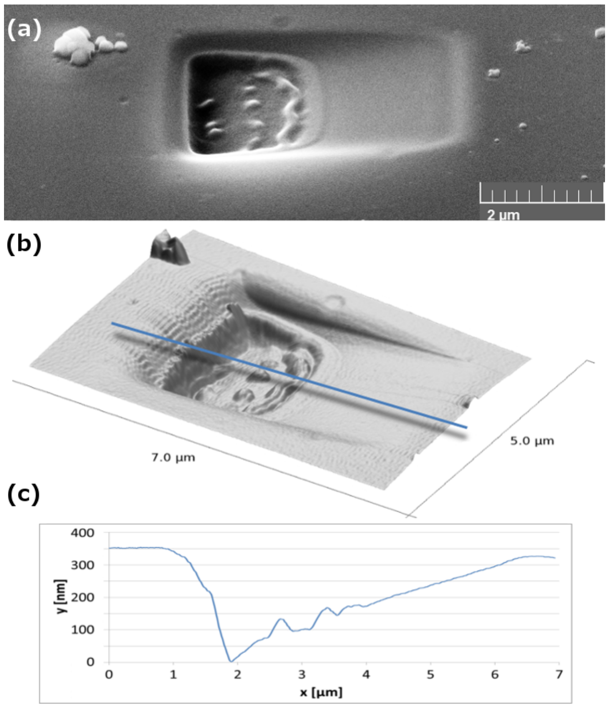

Fig. 2: DLC layer deposited on the Si wafer sputtered by the FIB. The DLC layer thickness is determined by the SPM module. (a) SEM image, (b) AFM image, (c) AFM profile.

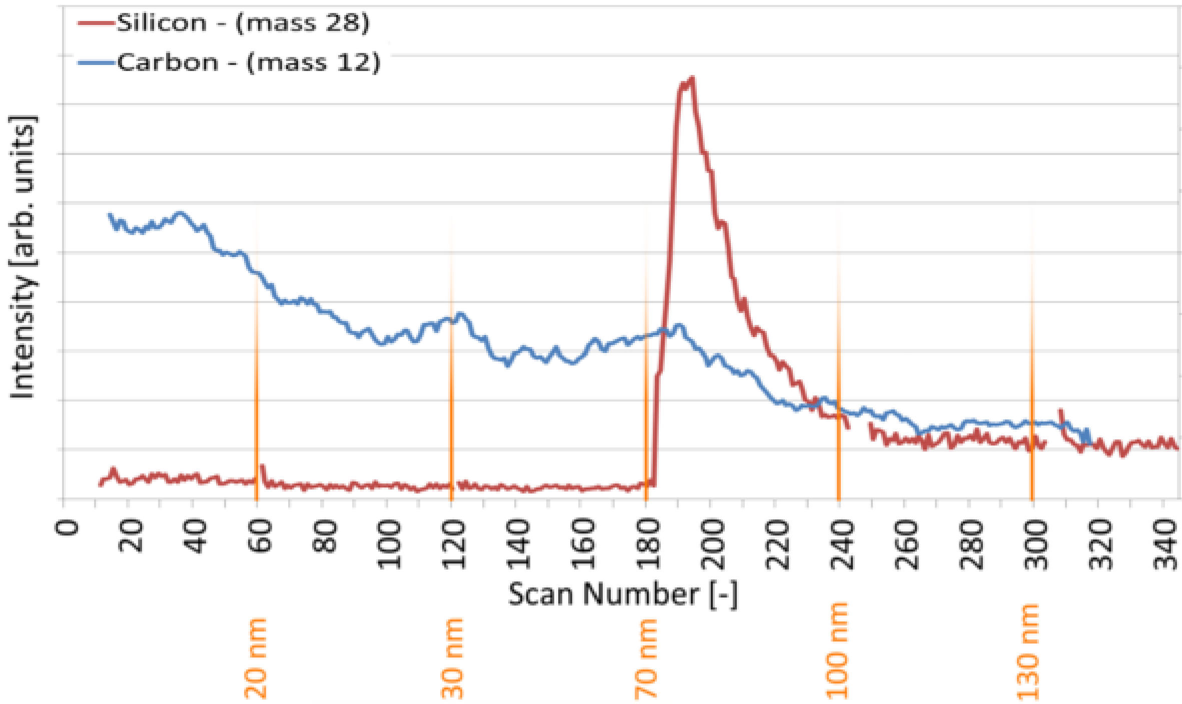

Fig. 3: Concentration depth profile of carbon and silicon in H:DLC layer measured by TOF-SIMS with the depth information provided by SPM. From the SPM depth measurements and the sharp increase in the silicon signal intensity the thickness of a DLC layer can be obtained.