The Effect of FIB Process Parameters on the Surface Morphology of Thin Lamellas

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Focused ion beam processing has become a versatile and well established method for the preparation of transmission electron microscope related lamellas, 3D reconstruction or nanoscale structuring [1]. Ion beam processed lamellas, however, can exhibit significant surface roughness values depending on the process conditions which can hamper reliable transmission electron microscopy (TEM) or electron energy loss spectroscopy (EELS) investigations due to varying t/ values or atomically resolved high resolution TEM imaging because of disturbing surface effects. Therefore, it is essential to gain quantitative information about ion beam induced surface roughness during e.g. TEM lamella preparation. In this study we investigate the influence of different preparation parameter during FIB processing via atomic force microscopy (AFM) and TEM. To enable such investigations we developed a simple and fast method of specimen preparation which allows also for several post-processing steps of the same sample to provide the comparability. In particular, we demonstrate the influence of the incidence angle for high energy ions (30 keV) at different beam currents as typically used for TEM lamella preparation. Afterwards, the effect of a low energy cleaning step at 5 keV is investigated revealing the competing processes of the amorphous layer removal [3] and the selective thinning for layer sequences with different materials. Finally, a procedure is presented which reduces the effect of surface morphology induced curtain like effect, enabling a more homogenous lamella preparation.

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30keV, 100pA, 2° milling angle

30keV, 100pA, 2° milling angle
5keV, 70pA, 7° cleaning angle

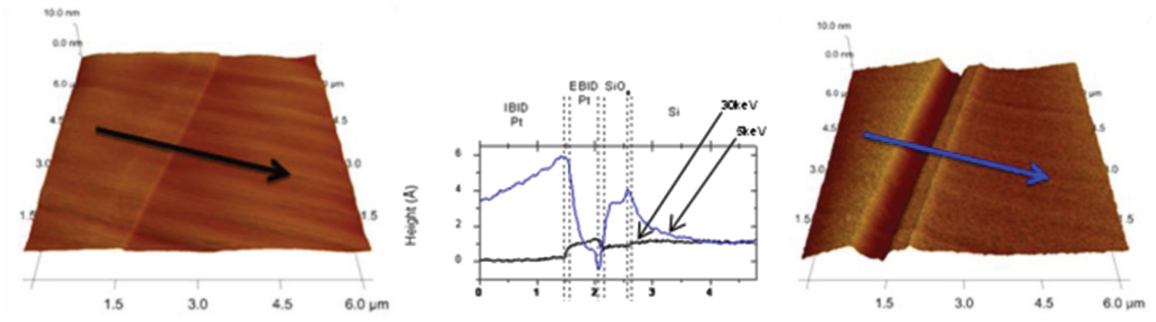
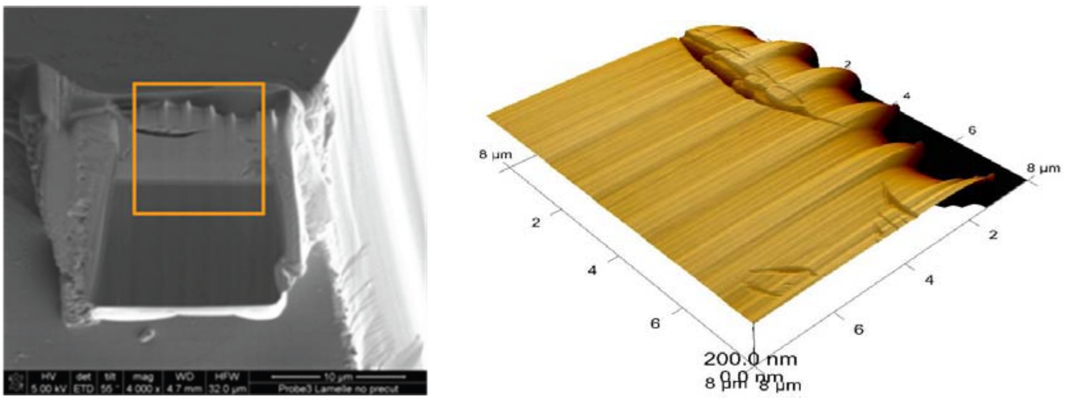


Figure 1. Left side: AFM measurement from a lamella milled with 30keV and 2° milling angle
Right side: AFM measurement from a lamella milled with 30keV and 2° milling angle and a low keV cleaning step at 5keV and 7° cleaning angle



Lamella with no pre cut on top of the Pt – layer

AFM height measurement

Figure 2. Left side: FIB SE image from a lamella with a rough Pt – surface (no pre cut)
Right side: AFM measurement from this lamella shows a morphological curtain like effect

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