DualBeam™ patterning in photonic materials

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The patterning capabilities of DualBeam instruments, which combine a focused ion beam (FIB) with a high resolution SEM in one instrument, are attracting a rapidly increasing numbers of prototyping applications. The live monitoring of FIB patterning for both milling and deposition gives operators a unique feedback loop, allowing direct process control and instantaneous optimisation of the processing parameters, thus resulting in largely reduced development times. The extending scope of applications is raising a demand for prototypes, even in cases where the material properties of the surfaces are crucial for device functionality, such as e.g. in nanophotonic devices.

The patterning with a FIB is known to cause Ga-implantation into bottom and sidewalls of structures. Crystalline substrate materials are subject to amorphisation. Both effects have been studied extensively for Si [1], however, data for materials that are common in photonic applications is not abundant. Figure 1 shows the damage layer in sidewall and at the bottom of a trench milled with a 30-kV FIB into InP.

An assessment of the impact of surface modifications on the characteristics of nanophotonic prototypes will require knowledge about Ga-concentrations, the degree of amorphisation and the respective profiles. This study aims at characterizing the impact of FIB patterning on various materials and the development of optimized patterning strategies in order to minimise the damage to surfaces of nanostructures. Experiments with InP show for instance that a significant reduction of the damage layer thickness can be achieved by lowering the energy of the incident Ga ions.

Reference:
[1] L.A. Giannuzzi, Reducing FIB Damage Using Low Energy Ions, Microsc. Microanal. 12 (Supp 2), 2006

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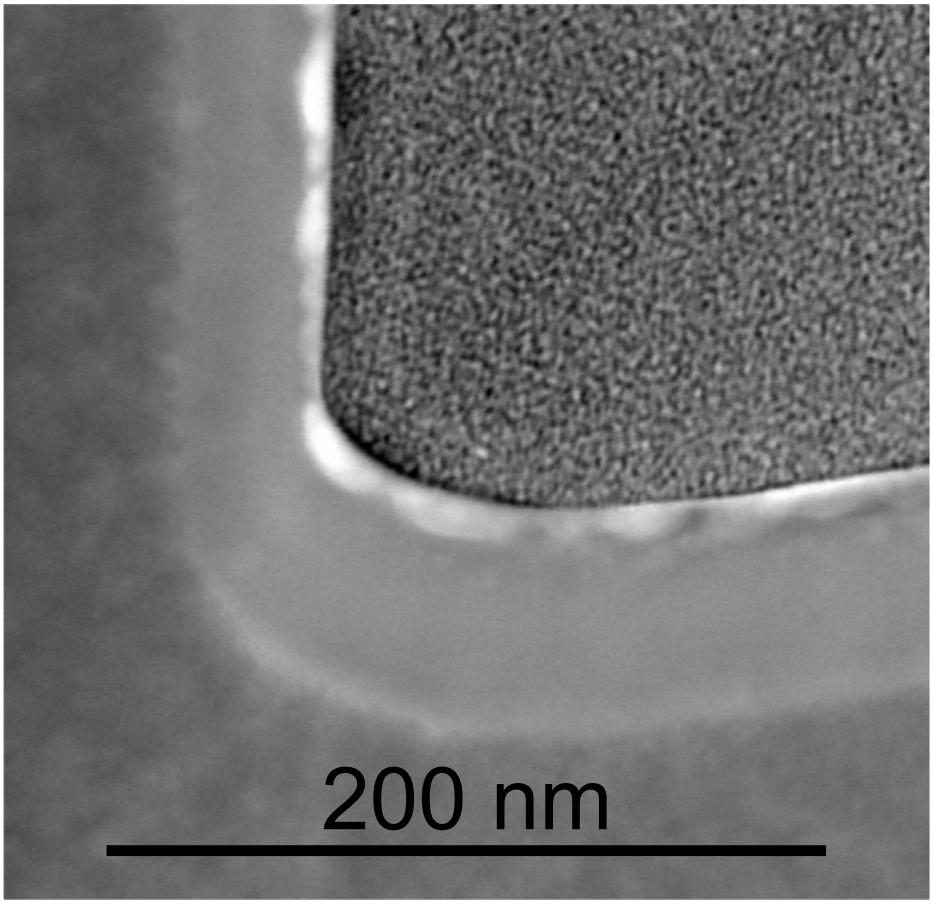

Fig. 1: TEM micrograph of the damage layer on the surface of a trench milled into InP with a 30-kV FIB. The trench was filled with electron beam deposited Pt prior to cross-sectioning and TEM sample preparation.