Preparation of Ni-Mn-Ga micropillars using Xe-ion beam milling for magnetic actuation on microscale

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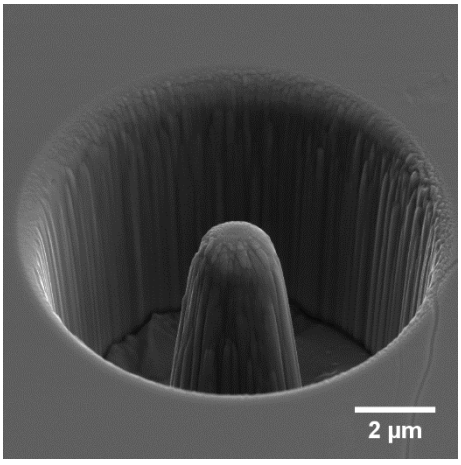
The fast and large actuation strain together with the possibility of remote operation by magnetic field makes the magnetic shape memory (MSM) alloys promising candidate for actuation on microscale. We considered fabrication of various micromagnetomechanical systems (MMMS) in analogy to microelectromechanical systems (MEMS). For a research and rapid prototyping of microscale structures and actuators based on MSM alloys, the focused ion beam (FIB) milling technique was used as one of the most advanced microstructure prototyping technology. In top-down approach, the well characterized macroscopic material is shaped into the microscopic devices.

In our work we investigate the possibility of using Xe-ion beam milling for Ni-Mn-Ga MSM single crystals. The FIB milling was performed using fully integrated Xe plasma source FIB with scanning electron microscope (FIB-SEM) TESCAN FERA3 GM. The process was monitored by secondary electrons imaging (Everhart-Thornley SE detector). We fabricated basic pillar structures in various sizes with different ion beam conditions.

In the poster, we will demonstrate various challenges we overcome during the fabrication of the structures such as ion channelling and resulting surface roughness, surface damage due to ion implantation, and possible size limits of the current approach. We will also introduce the actual MSM functionality (magnetic actuation) of the fabricated structures in magnetic field.



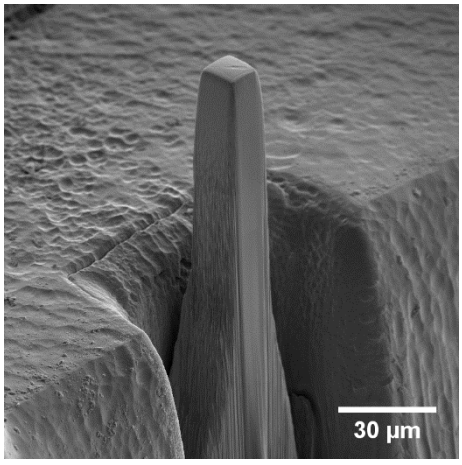


Fig. 1 Fabricated micropillar with a diameter in the range of a few µm for testing the size limits

Fig. 2 A 10x10x60 μm^3 micropillar prepared for magnetic microactuation

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