FEMTOSECOND LASER AND FIB: A REVOLUTIONARY APPROACH IN RAPID MICRO-MECHANICAL SAMPLE PREPARATION

Manuel J. Pfeifenberger, Montanuniversität Leoben, Austria
manuel.pfeifenberger@oeaw.ac.at
Anton Hohenwarter, Montanuniversität Leoben, Austria
Daniel Kiener, Montanuniversität Leoben, Austria
Reinhard Pippan, Montanuniversität Leoben, Austria

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The established Focused Ion Beam (FIB) technique usually poses a bottleneck in the preparation of samples for micro-mechanical experiments. This is due to its limited material removal rate. Especially for tungsten, the sputter yield of the Ga^+ ion beam is very low. Therefore the practical sample size is restricted to dimensions of a few micrometers. On the contrary a femtosecond laser offers ablation rates 4-6 orders of magnitude higher compared to a Ga^+ FIB [1] and therefore allows a rapid fabrication of specimens on the meso-scale.
A prototype, which combines both methods, has been developed on the basis of the Zeiss Auriga Laser platform [2]. This system consists of the main chamber, where the FIB milling is conducted, and a separated airlock chamber for the femtosecond laser ablation. This setup prevents the contamination of the main chamber with laser ablated material and allows laser processing under atmospheric, inert gas or vacuum conditions.
Fracture toughness experiments on single crystal tungsten in the micro-regime [3] exhibit a different behavior compared to specimens on the macro-scale [4]. The rapid processing of specimens with the novel laser system allows to sample the transition region from a discrete flow behavior of the micro-sized cantilevers to macroscopic plasticity. An analysis of fracture experiments for sample sizes ranging from 20 x 20 x 100 µm^3 to 200 x 200 x 1000 µm^3 is conducted. In addition to that, the quality of the laser processed samples is analyzed regarding the influence of processing parameters.

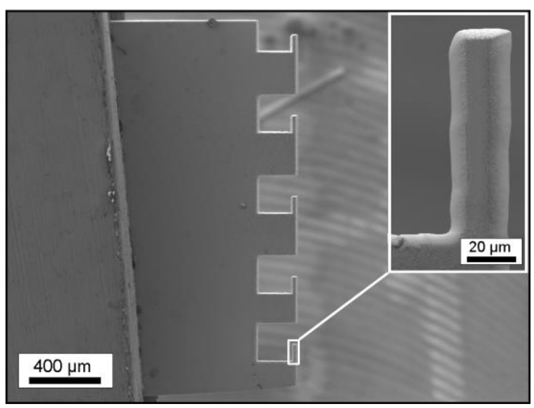

Figure 1 – 5 cantilevers with a dimension of 20 x 20 x 100 µm^3 cut in a tungsten single crystal. Each cantilever is cut in about 4 minutes.

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