FAST FABRICATION OF MICROPILLAR ARRAYS USING A COMBINATION OF LASER AND FIB FOR MICROMECHANICAL COMPRESSION TESTS

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Micropillar compression testing is a promising technique used to probe the uniaxial stress-strain response and to determine the mechanical performance of materials such as metals and alloys. One of the distinguishing features - and a major advantage - of micropillar compression test is that only a small volume of material is required to quantify the deformation mechanisms. It is the most economic and efficient way to optimize the material processing parameters, for example, in Additive Manufacturing (AM). AM based on layer-by-layer material deposition techniques is introducing a new era of manufacturing technology which goes beyond traditional subtractive manufacturing. Mechanical testing at a microstructural and/or layer thickness level plays an important role in understanding as well as optimizing the complex relationships between the basic process parameters and the final product of the AM process.

Conventionally micropillars are machined using FIB which is extremely time-consuming and only pillars smaller than 10 μm in diameter are attainable. Thus, fabrication of good quality micropillar arrays with great control over their size and location in a large test volume has not been possible to date. In this work, an all-in-one LaserFIB solution to speed up the fabrication of micropillar arrays is introduced. A femtosecond laser is used to fabricate micropillar arrays over an area of hundreds of microns up to centimeters within minutes. Achievable pillar diameters are of the order of 20-50 μm. Micropillar arrays and pillars with various sizes have been fabricated to have more statistically relevant test results. The machined micropillar arrays with clean top loading surfaces are deformed with a flat punch indenter to measure the individual stress-strain curves in a SEM.

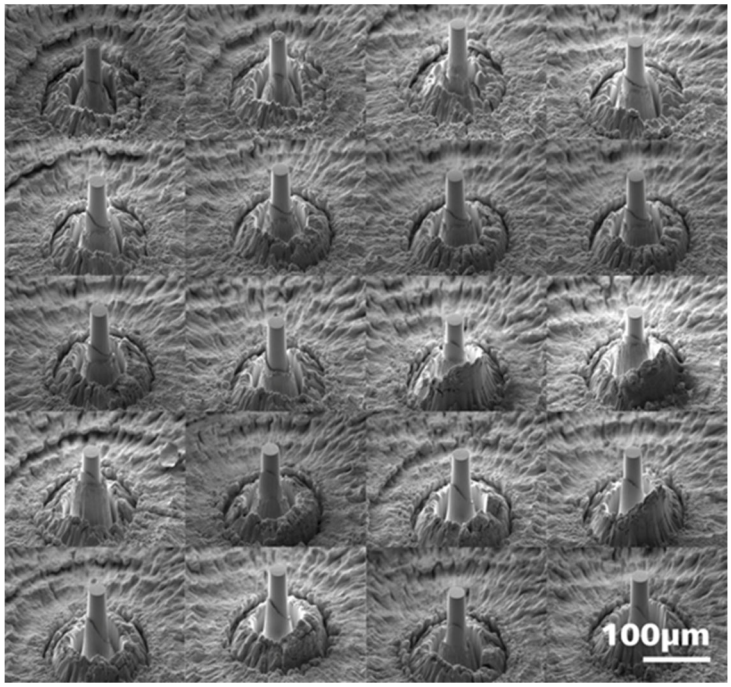

Figure 1 – 20 micropillars are prepared by means of an optimized LaserFIB workflow. On average it takes less than 3 hours to create one pillar, which is much faster than the conventional FIB fabrication method.

Pillar size: 25µm in diameter

The sample is the additively manufactured hardmetal WC-12Co by courtesy of Steven Moseley from HILTI.