MASTER SEMESTER PROJECT-PROPOSAL

LABORATORY OF MECHANICAL METALLURGY (LMM)

Evaluation of Micro-Tensile Properties of Silver Alloys Obtained by Femto-Cast Process

A metal infiltration process of micro-machined fused silica preforms subsequently infiltrated with liquid metal that is later solidified will be utilized in order to produce micro-tensile test specimens (Fig. 1). In the first step of the process, a selective region of the silica substrate is exposed to low-energy femto-second laser pulses at the Galatea Laboratory of EPFL. After that, the material is held in a HF bath (with full respect of stringent safety precautions) for a specific time in order to selectively etch the region previously exposed to the femto-laser. Once a micrometre-size hollow pattern is obtained within the glass, a liquid metal is infiltrated at Laboratory of Mechanical Metallurgy (LMM). After fully etching the silica substrate, the final parts are free-standing metallic micro-pieces. A schematic illustration of the process is shown in Fig. 2.

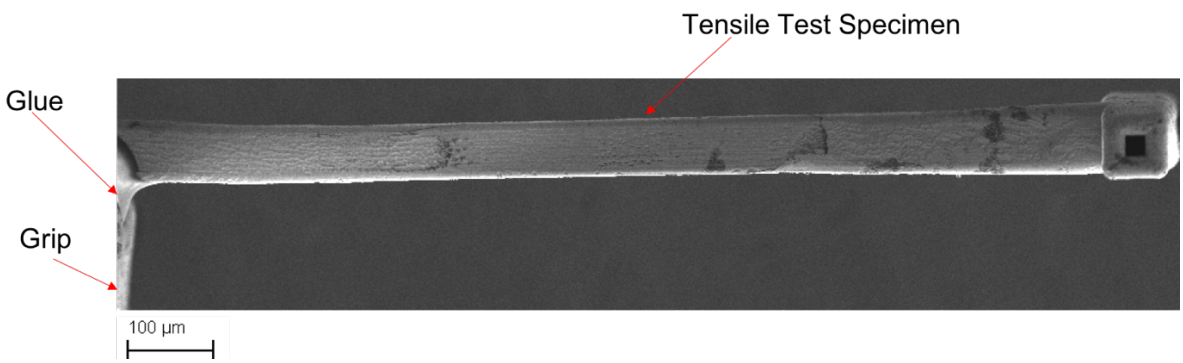

Fig. 1 *Tensile Test Specimen prepared by femto-cast process.*

During this project, the tensile properties at small scale of a silver alloy will be analysed. More specifically, the goals are (i) to develop and investigate new potential alloys such as Ag-Au (their behaviour during the infiltration process, microstructural features, etc.) and (ii) to study the mechanical behaviour of the alloys at small scale. Unlike the plastic deformation of a bulk metal, which takes place through smooth and homogeneous flow, uniaxial tests on micro- and nanoscale metallic samples generally show an increase in the plastic flow stress as the sample size decreases. One can also observe intermittent, heterogeneous deformation also known as jerky flow because of the limited size and number of dislocations available within the sample [1-3].

The student will experience the processing and manipulation of shaped metal parts in the micrometer range and will acquire practical knowledge of characterization techniques such as micro-tensile testing, optical microscopy, hardness testing, scanning electron microscopy.

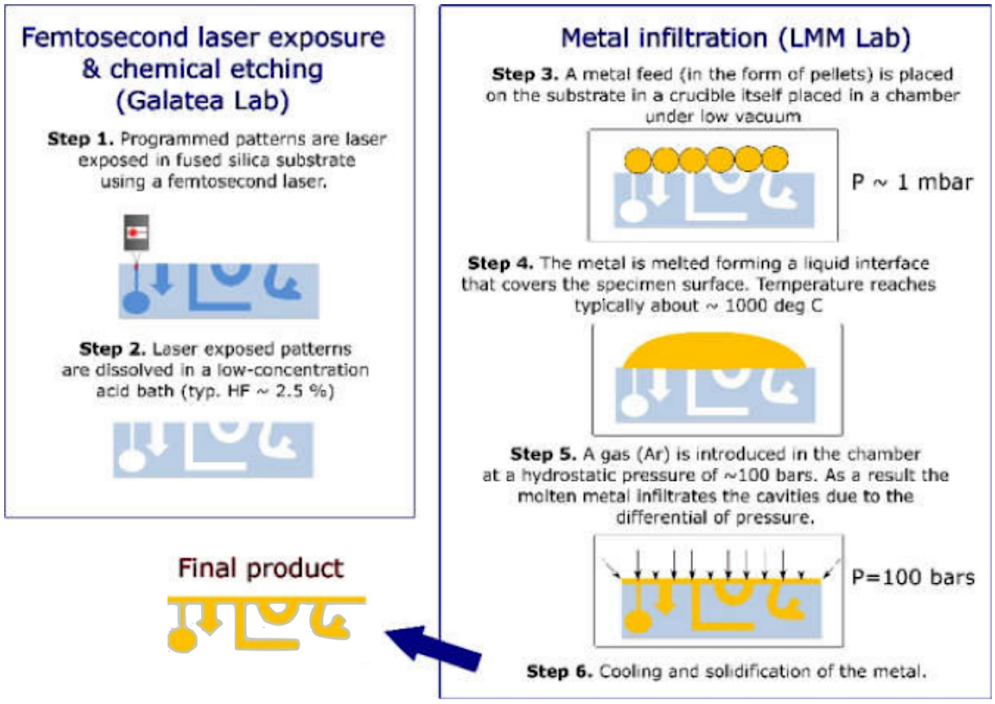

Fig. 2. A schematic illustration of the process.

[1] L.P. Kubin, Dislocations, Mesoscale Simulations and Plastic Flow, Oxford Univ. Press. (2013).
[2] M.D. Uchic, P.A. Shade, and D.M. Dimiduk, Plasticity of micrometer-scale single crystals in compression, Ann Rev Mater Res 39 (2009), pp. 361-386].
[3] J. R. Greer and J. T. M. De Hosson, “Plasticity in small-sized metallic systems: Intrinsic versus extrinsic size effect,” Prog. Mater. Sci., vol. 56, no. 6, pp. 654–724, Aug. 2011.

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