

Supplementary Material for - Plastic flow under shear-compression at the micron scale – application on amorphous silica at high strain rate

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Finite Element Modeling of the Plastic flow under shear-compression at the micron scale - effects of the gauge geometry

The main issue with FIB machining is the gauge width variation. The conical shape of the ion beam (i.e. cone angle about 8°) results in a slightly larger groove section at the bottom of the pillar. The effect of this parameter is checked here through finite element modeling. For that purpose, we consider here the pillar's geometry described in figure S-1. The gauge width is ~1.3 μm on the front face and 1.5 μm on the rear face.

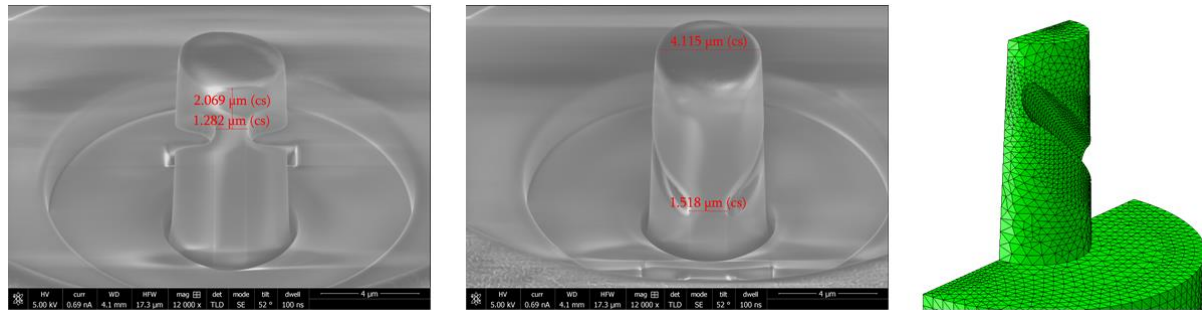


Figure S-1: gauge geometry and position on the pillars measured from SEM images and corresponding finite element mesh. Left: front view – the gauge width is ~1.3 μm . Middle: rear view – the gauge width is ~1.5 μm . Right: Finite Element Mesh considering a constant gauge width ~1.4 μm .

Finite element results considering the real geometry (conical shape) and a constant gauge width of ~1.4 μm are compared in Figure S-2. This width value is the half value between the width measured on the front face and the one on the rear face. The mesh of the constant gauge width model is shown in Figure S.1-right. The load displacement curves are almost superimposed. Consequently, considering a groove FIB-induced conical shape or a gauge with a constant width leads to the same results if the width is chosen as the half of front face width and the rear face width. The same results were obtained for the geometry 1 with a smaller gauge width.

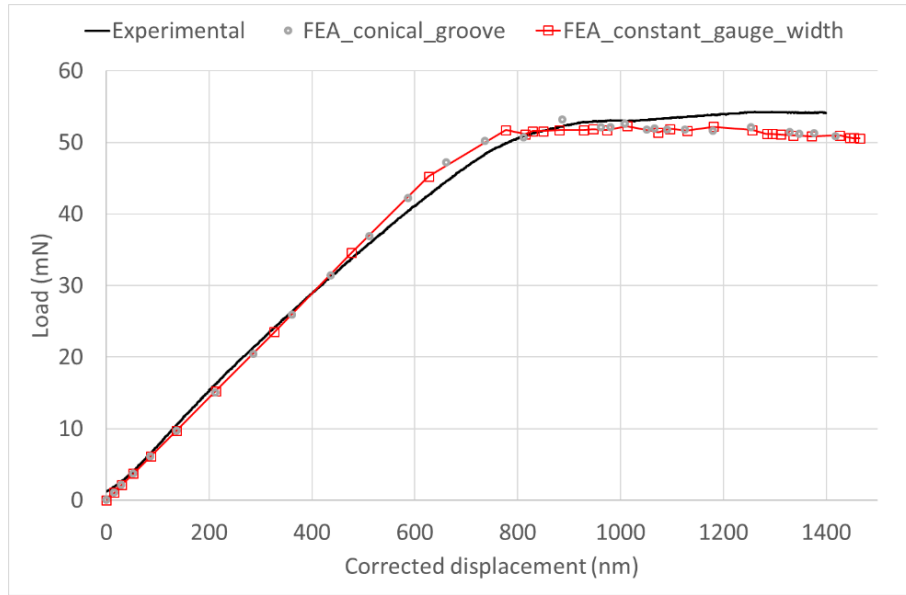


Figure S-2: Load-displacement curves – The FE Analysis considering a groove FIB-induced conical shape or a gauge with a constant width led to the same curves and matched the experimental results.

True stress-true strain experimental curve measured by in situ micropillar compression

In the paper, the elastic behaviour measured by in-situ micro-compression was not plotted in Fig. 4 in order to be in accordance with shear data where the elastic behavior cannot be calculated using the Dorogoy *et al.* expressions [1]. Figure S-3 presents the experimental data measured by micro-compression at low and high strain rates, in the elastic and plastic domains. The elastic behavior is independent of the strain rate. For 1000s^{-1} strain rate, the elastic part seems different from the ones at lower strain rate, but the data must be taken with care because of sampling frequency limitation (50kHz).

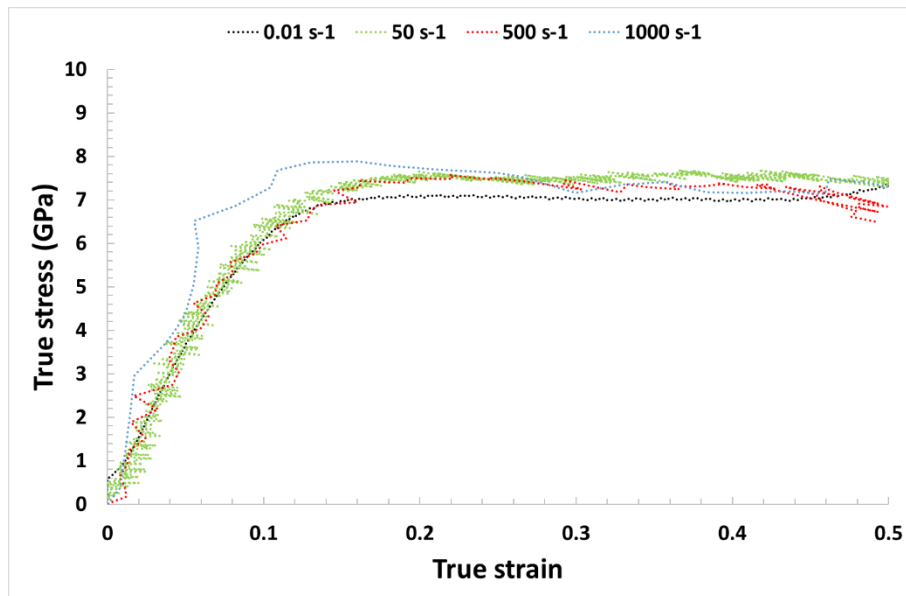


Figure S-3: True stress-true strain curve measured by in situ micropillar compression at low and high strain rates

Stress distribution in the gauge

Figure S-4 shows the Von Mises stress distribution on the gauge (geometry 2, flat punch free laterally) during plastic deformation. As shown here, the stress distribution is homogeneous along the gauge and

is around 7GPa, which is consistent with the stress value calculated experimentally using the Dorogoy *et al.* expressions (see Figure 4).

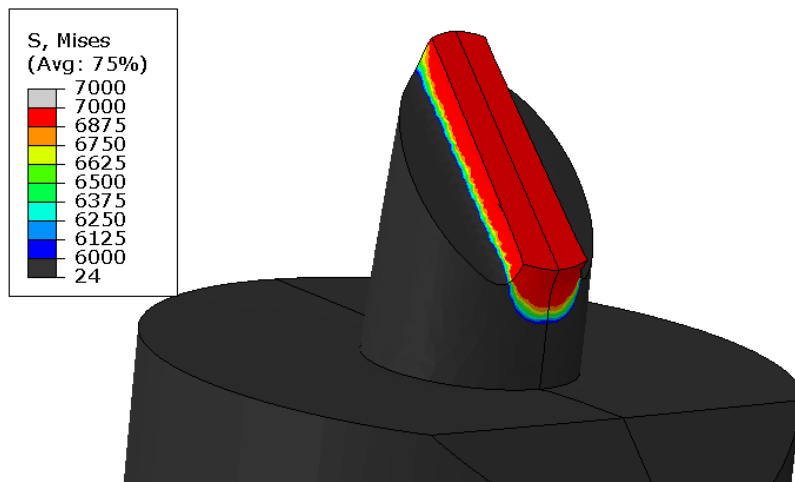


Figure S-4: Von Mises stress distribution along the gauge axis obtained by Finite Elements simulation.

Reference

1. A. Dorogoy, D. Rittel, and A. Godinger, Exp Mech **55**, 1627 (2015).