EVIDENCE OF ELECTRON-IRRADIATION ACTIVATED CREEP IN AMORPHOUS OLIVINE AT ROOM TEMPERATURE

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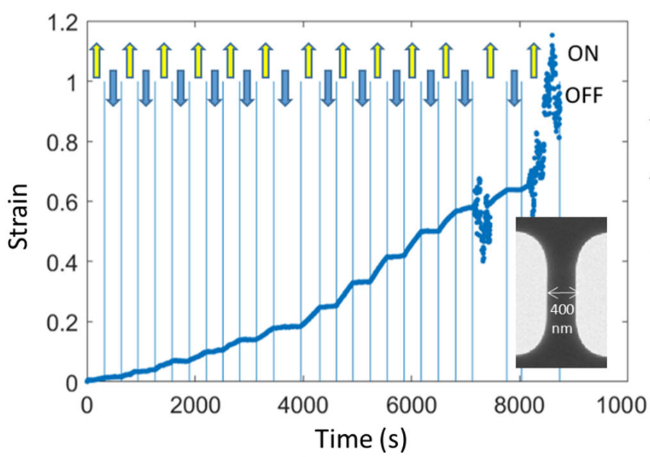
Oxide glasses are the archetype of brittle materials, but they are known to exhibit large ductility when loaded at a submicronic scale. For instance, micron-sized silica pillars were successfully compressed up to large plastic strain without failure [1]. Amorphous alumina exhibits large tensile ductility at the size of a few hundreds of nm [2]. Most of these results were obtained using *in situ* nanomechanical testing in SEM or TEM to allow imaging the deformation mechanisms. However it was observed that electron irradiation sometimes played a role on the ability of these materials to sustain such large plastic strain [3], which might lead to some erroneous conclusions. In this paper we propose a methodology to investigate the effect of electron-irradiation during *in situ* tensile testing with a push-to-pull device from Bruker.Inc. The governing idea is to use multiple beam off – beam on cycles during pulling. Hence electron-irradiation activated plastic flow can be evidenced and modeled using unidimensional mechanical calculations. This method is applied to amorphous olivine, a silicate with $(Mg,Fe)_2SiO_4$ composition. It is clearly shown that creep is enhanced during electron-irradiation leading to a strong increase of the strain rate with a decrease of the applied stress. The use of a simple uniaxial elastic-viscoplastic formalism allows the quantification of yield parameters such as the strain-rate sensitivity. In the case of amorphous olivine, a surprising Newtonian-like flow is highlighted at room temperature.



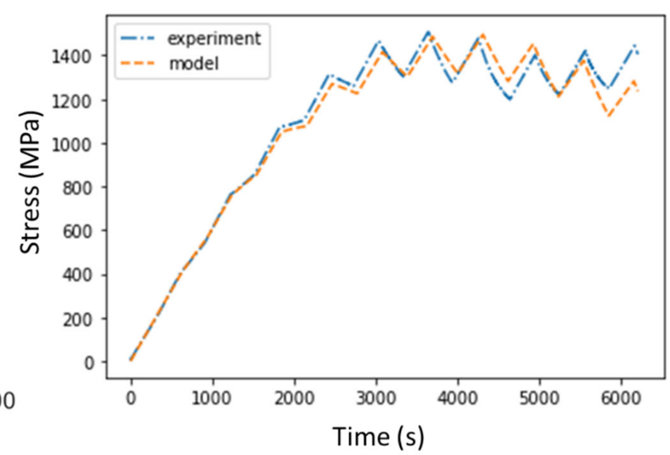


Figure 1 – Electron-irradiation activated creep during in situ tensile testing of amorphous olivine. Left – increase of the strain rate due to electron-irradiation. Right – decrease of the stress due to electron irradiation

[1] Kermouche, G., *et al.* "Perfectly plastic flow in silica glass." Acta Materialia 114 (2016)
[2] Frankberg, Erkka J., *et al.* "Highly ductile amorphous oxide at room temperature and high strain rate." Science 366.6467 (2019): 864-869
[3] Mačković, Mirza, *et al.* "A novel approach for preparation and *in situ* tensile testing of silica glass membranes in the transmission electron microscope." Frontiers in materials 4 (2017): 10.