Plasticity and hysteretic behaviour of silicate glasses under high pressure

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Abstract

By means of Raman microspectroscopy, we have investigated a soda-lime-silicate glass at high pressures up to 20 GPa, and evidence memory effects during hydrostatic loading-unloading cycles (1). Indeed, for a non-densified silicate glass, the transformation is perfectly reversible, but when the glass is densified, the stress-strain curve show closed hysteresis loops. Our results directly point to the existence of plasticity related metastable structures. For a better understanding of this phenomenon at the structural scale, we have also studied the mechanical behaviour of the glass through molecular dynamics simulations. Following the structure during loading-unloading cycles, we found evolutions which provide a reasonable explanation for the Raman observations: the distribution of the Qn species also presents a hysteretic behaviour. We have also build up an evolution equation to describe the memory effect and discuss the parameter values at the light of the MD results. By comparing the mechanical behaviour of pure silica with silicate glasses, we shed direct light on the specific impact of sodium on plasticity mechanisms and the presence of metastable states in silicate glasses. (1) T. Deschamps *et al.*, "Memory effect in the plasticity of a silicate glass densified at room temperature", Phys. Rev. B **105**, 224206 (2022)

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