Effect of high pressure on the atomic dynamics of a Au-based metallic glass

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Abstract

The understanding of how pressure influences the rich phenomenology of glasses attracts the scientific community not only from a theoretical point of view, but also for technological applications. This is particularly true for metallic glasses (MGs), which exhibits suppression of shear banding and inhibition of catastrophic mechanical failures under quasi-hydrostatic compression, making deformed MGs appealing for technological applications (1).
Historically, the use of pressure as an experimental variable mainly concerned the study of macroscopic quantities, owing in part to experimental convenience. Nowadays, our understanding of the microscopic structural and dynamical effect of deformation in MGs is limited to ex situ densified glasses. The recently developed 4th generation synchrotron sources, like the ESRF synchrotron in France, made in situ pressure-dependent studies experimentally achievable thanks to a 100 times higher coherent flux (up to 1012 photon/s).
This work investigates the atomic scale in situ pressure-dependence of a Au-based MG by X-rays photon correlation spectroscopy (XPCS). From the structural point of view, pressure
is found to induce a reversible elastic densification of the system, while the dynamics exhibits an hysteresis upon compression and decompression. Moreover, under hydrostatic compression the atomic motion accelerates, as indicated by a decrease in the characteristic relaxation time of the system, which suggests rejuvination. Our results support recently developed theories predicting rejuvination of MGs under compression (2-3).
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