

Pressure-induced non-monotonic crossover of steady relaxation dynamics in a metallic glass

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Relaxation dynamics, as a key to understand glass formation and glassy properties, remains an elusive and challenging issue in condensed matter physics. In this presentation, I will introduce our recent development of in situ high-pressure synchrotron highenergy x-ray photon correlation spectroscopy (Fig.1a), which enable us to probe the atomic-scale relaxation dynamics of a cerium-based metallic glass during compression. Although the sample density continuously increases, the collective atomic motion initially slows down as generally expected and then counter-intuitively accelerates with further compression (density increase), showing an unusual non-monotonic pressure-induced steady relaxation dynamics crossover at ~ 3 GPa. Furthermore, by combining in situ high-pressure synchrotron x-ray diffraction, the relaxation dynamics anomaly is evidenced to closely correlate with the dramatic changes in local atomic structures during compression, rather than monotonically scaling with either sample density or overall stress level (Fig.1b and c). These findings could provide new insight into relaxation dynamics and their relationship with local atomic structures of glasses. It is worth emphasizing that the technique developed and demonstrated in this work will strongly benefit from the advent of diffraction-limited synchrotron sources with largely enhanced coherent x-ray flux, allowing to dramatically extend the accessible dynamical range using high-energy x-ray.

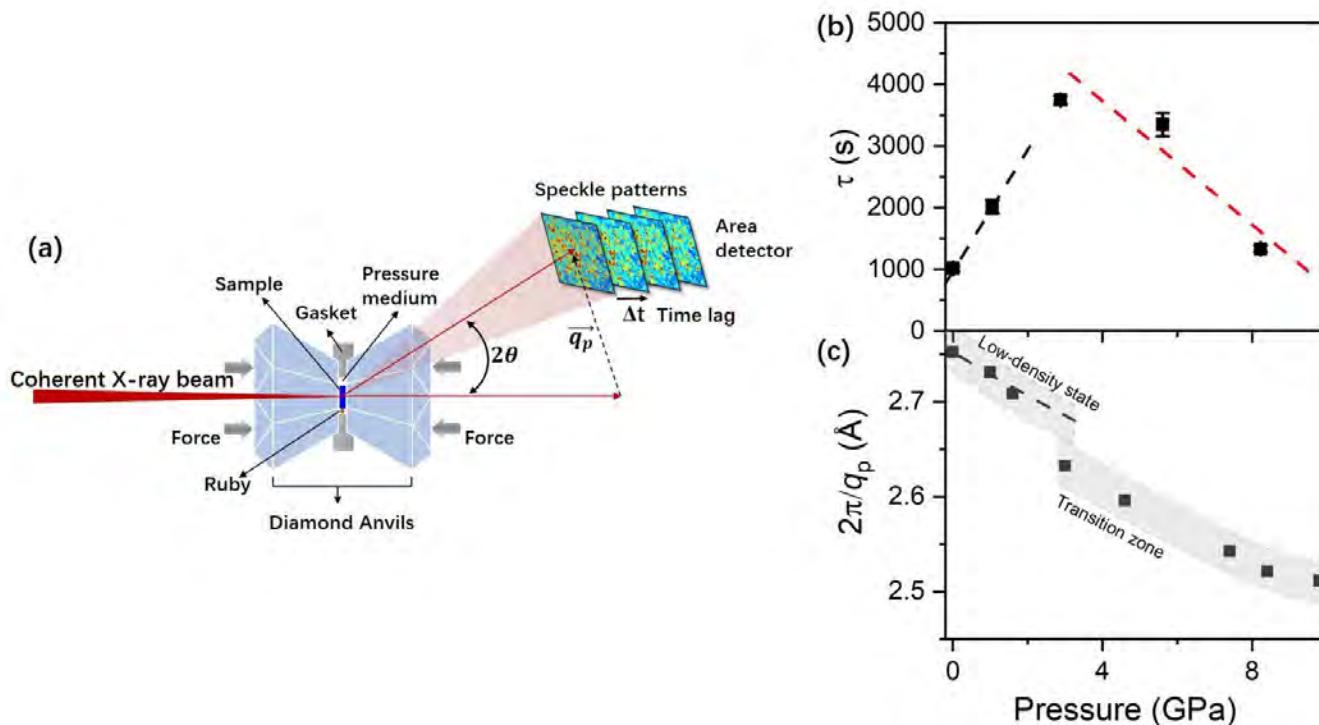


Figure 1. (a) A schematic illustration of the experimental setup for in situ high-pressure high-energy x-ray photon correlation spectroscopy experiments using a symmetric diamond anvil cell. A close correlation is revealed between steady structural relaxation time (b) obtained by in situ high-pressure synchrotron high-energy x-ray photon correlation spectroscopy and structural changes monitored by the inverse diffraction peak position shift (c) as a function of pressure. The dotted and dashed lines and gray zones are guides to the eye. Error bars in (c) are smaller than the symbol size.