Ex-situ Raman Investigation of Indentations in Vitreous Silica

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Abstract

Decades of research have led to the conclusion that glass plastically deforms by two mechanisms: densification and shear. In indentation, densification has been associated with "anomalous" glasses containing low amounts of modifiers, whereas shear has been associated with "normal" glasses rich in modifiers. We have combined Raman spectroscopy with indentation techniques to probe local structural changes in silica glass induced by densification. We collected spectra of pristine silica which and compared them to spectra obtained from inside indentations at different loads. We observed large structural changes in the silica which vary continuously with increasing indentation load. In this talk, we clarify the role of the stress state in the atomic mechanisms of plastic deformation by comparing our indentations to the results of many other studies in which silica was hydrostatically compressed at various maximum pressures and temperatures. We are able to attribute differences in the spectra to specific factors such as: shear stress, stress gradients and temperature. We observe that the structural changes induced by indentation are most similar to the structural changes induced by high temperature hydrostatic compression.

Keywords: Densification, plasticity, silica, Raman, indentation

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