Metastable melting under compression and decompression

Guoyin Shen

Geophysical Laboratory, Carnegie Institution for Science, USA; Email: gshen@ciw.edu

An interesting feature of some materials is their vitrification below the glass transition temperature T_g, through either heating a metastable high pressure phase at ambient pressure, or through compression (decompression) of a low (high) pressure phase to a pressure domain outside its stability field, with the latter commonly referred as pressure induced amorphization. It is found that vitrification generally occurs when the trajectory of the representative point in P-T space crosses the extrapolated melting curve. Hence, such vitrification is often viewed as a phenomenon of metastable melting. However, little attention seems to have been paid on metastable melting at temperatures above T_g. Given the wide existence of supercooled liquids, it could be possible for a metastable liquid to exist when pressure pathways cross the extrapolated melting curve above T_g. In this talk, we will discuss the experimental results from synchrotron x-ray diffraction for H_2O, and present evidence of metastable water formed under rapid decompression in a temperature range within the so-called “no man’s land”. Strongly depending on the temperature, the metastable water is found to appear only a short period, from a few milliseconds at 165 K to a few hundred seconds at 150 K, then transforming to ice-I phase. In experiments on bismuth, however, we found that the metastable liquid bismuth can exist for hours, until external perturbation is applied. Implications of these observations will be discussed.