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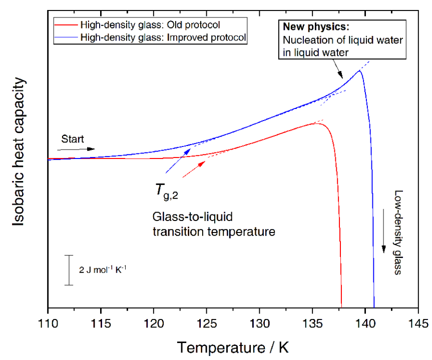
Examining the second glass transition without pressure-induced ice amorphization via micron-sized water droplets



The existence of two different liquids in the single component system water has been a significant field of inquiry since it was first proposed in 1992. Previous examinations of the transformation from "glass" (a solidified state produced without formation of crystals) back to the liquid state have primarily focused on amorphous samples made from crystalline ice.

A new study reveals evidence for the existence of two liquids through a different approach. Avoiding crystallinity at all stages, Bachler et al. investigated the glass transitions based on genuine glassy water prepared from micron-sized liquid water droplets.

"In fact, we prepare glassy water in the most intuitive way – by rapidly cooling the liquid," said author Johannes Bachler. "This necessitates cooling to below 140 Kelvin with rates faster than 1 million Kelvin per second and avoids ice that would otherwise crystallize rapidly."

Plunging the glassy product into liquid nitrogen has allowed the researchers to subject it to various compression and heating cycles. Differential scanning calorimetry thermograms of the densified glasses at ambient pressure demonstrate their transformation into a highly viscous liquid. Removal of nuclei in the compression and heating step is key to avoid premature conversion of the viscous liquid.

"Since our samples are directly made from liquid water, we claim that this glass transition is the genuine transition to high-density water – a claim that was hard to justify with amorphous ices," said author Thomas Loerting.

The new findings provide guidance in how to prepare the ultraviscous high-density liquid with highest thermal stability at ambient pressure, opening the door to new physics with the nucleation of low-density water in high-density water at 140 K.

Source: "Pressure-annealed high-density amorphous ice made from vitrified water droplets: A systematic calorimetry study on water's second glass transition," by Johannes Bachler, Johannes Giebelmann, Katrin Amann-Winkel, and Thomas Loerting, *Journal of Chemical Physics* (2022). The article can be accessed at http://doi.org/10.1063/5.0100571.

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