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Vibrational density of state of the ideal glass

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The vibrational density of state (VDOS) of the most stable crystal of a given species follows the prediction of the Debye model. In contrast, glasses generally exhibit excess in the VDOS visible as a bump in the meV range and widely known as the boson peak. Its magnitude depends on the thermodynamic state of the glass. Specifically, the magnitude of the boson peak scales with the entropy and energy of the glass.

In the present contribution, we employ a model system of polymer nanospheres, where the thermodynamic state can be tuned at wish by manipulating the amount of free interface and the annealing time deep in the glassy state, to study the effect of deeply reducing the glass energy on the VDOS. In doing so, we show that, in appropriate conditions, the thermodynamic state of the glass can be reduced down to the condition of entropy matching that of the crystal. We show that in this state the boson peak of the glass is essentially suppressed and, therefore, the VDOS mimics that of the crystal. We interpret this results as a signature of the transformation of the glass into a new state, named “the ideal glass”, long ago theorized, whose existence is in this way demonstrated.

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