Low-temperature glassy anomalies in highly stable glasses

Miguel Angel Ramos*[1]

[1]Laboratorio de Bajas Temperaturas, Departamento de Física de la Materia Condensada, Universidad Autónoma de Madrid, E-28049 Madrid – Spain

Abstract

We have investigated how very deep kinetic and thermodynamic stabilization in glasses can affect their universal properties at low temperatures. In particular, we have studied two different materials which allowed us to access highly-stable glassy states, as well as their corresponding conventional glasses: (i) ancient amber [1], which is a glass which has experienced an extremely long hyperaging process; and (ii) ultrastable thin-film glasses of indomethacin [2], prepared by physical vapor deposition at temperatures around 0.85 Tg. Specifically, we have studied 110-million-year-old amber samples from El Soplao (Spain). Specific heat Cp measurements of pristine and rejuvenated samples were conducted in the temperature range 0.07K $<$ T $<$ 30K, as well as around its glass-transition temperature Tg = 423 K. A modest increase of the boson-peak height (in Cp /$T\hat{}3$) with increasing rejuvenation was observed. The amount of tunnelling two-level systems (TLS) was however found to be exactly the same for the pristine hyperaged amber as for the subsequently rejuvenated samples. On the other hand, we have observed an unexpected suppression of the universal TLS in the ultrastable glass of indomethacin, whereas conventionally prepared thin films of the same material exhibited the usual linear term in Cp below 1 K, usually ascribed to TLS in glasses.

REFERENCES:

1. Pérez-Castañeda, T., Jiménez-Riobóo, R. J., Ramos, M. A., Two-Level Systems and Boson Peak Remain Stable in 110-Million-Year-Old Amber Glass, Phys. Rev. Lett. 112, 165901 (2014).

2. Pérez-Castañeda, T., Rodríguez-Tinoco, C., Rodríguez-Viejo, J., Ramos, M. A., Suppression of tunneling two-level systems in ultrastable glasses of indomethacin, PNAS 111, 11275 (2014).

Keywords: specific heat, low, temperature universal properties of glasses, amber, ultrastable glasses, aging, boson peak, two, level systems

*Speaker