Experimental 'short cut' reduces from millennia to minutes the time needed to measure glass viscosity

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Researchers from the Universitat Autònoma de Barcelona and the MATGAS research centre, the Universitá di Roma "La Sapienza" and the Politecnico di Milano have designed a method which indirectly measures the viscosity of glass - something that required unfeasible observation times at human scale - based on its elastic properties. The results of the research, published this week in *PNAS*, questions the validity of current theories of glass formation

Glass is a solid material, but has such a chaotic structure that it could be considered a liquid with an extraordinarily high viscosity. It flows like a liquid, but at low temperatures molecular mobility is so low that experimental observation is impracticable. The vitreous state of glass continues to be one of the great mysteries of Condensed Matter science, given that scientists consider their understanding of it far from satisfactory.

A team of scientists from the UAB and the MATGAS research centre, the Universitá di Roma "La Sapienza" and the Politecnico di Milano have been able to relate the ultra-viscose properties of liquid (experimentally inaccessible at very low temperatures) with the corresponding elastic properties of glass, rapidly obtained through optical and synchrotron radiation techniques.

These properties are measured according to the age of the glass and thus, theoretically, it is essential to use samples which have aged through geological cycles. Nevertheless, researchers used ultrastable glass formed in short periods of time (from minutes to hours) through a technique known as "physical vapour deposition". The glass synthesised by the researchers Cristian Rodríguez-Tinoco and Javier Rodríguez-Viejo, from the UAB Department of Physics, can be compared in stability to ambers which have aged naturally during tens of millions of years, and thus allows researchers to measure the viscosity of glass equivalent to that found in the asthenosphere, the upper mantle of the Earth.

While measuring the viscosity of these materials scientists reached an unexpected conclusion. Although current models predict that glass stops flowing at a certain temperature, the results of this study are the first to reveal that this prediction is actually not true, and therefore current theories on this state of glass may not be correct. Scientists have demonstrated experimentally that glass in equilibrium flows visibly at finite temperatures, putting into question one of the pillars of the theory on the vitreous state of glass.

Advance in knowledge on this glass, known as ultrastable, also has practical implications, given that it could be important in applications such as the elaboration of more stable pharmaceutical compounds than those achieved with crystallisation. It also has implications for the use of organic light-emitting diodes (OLEDs), due to its greater thermal stability and lower degradation in absorption of gases, such as water vapour, which permits these devices to function longer without suffering the effects of environmental perturbations.

More information: Eva Arianna Aurelia Pogna, Cristian Rodríguez-Tinoco, Giulio Cerullo, Carino Ferrante, Javier Rodríguez-Viejo, and Tullio Scopigno. "Probing equilibrium glass flow up to exapoise viscosities." *PNAS* 2015 February 9, 2015, DOI: 10.1073/pnas.1423435112

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