MAR15-2014-020166

Abstract for an Invited Paper
for the MAR15 Meeting of
the American Physical Society

Atomic motion and physical aging in structural glasses revealed by coherent X-rays

BEATRICE RUTA, ESRF-The European Synchrotron, Grenoble.

Glasses are essential materials in present day science and technology. Nevertheless, many of their properties remain the subject of numerous studies, since their intrinsic non-equilibrium nature poses formidable problems both at the technological and fundamental level. Although their physical aging has practical implication for material science, a microscopic understanding is still missing since experiments that study the dynamics at the microscopic level are extremely challenging [1]. Here, we will report on the first experiments that follow the evolution of the structural relaxation process in glasses at the atomic length scale. Measurements on metallic glasses have revealed the existence of microscopic structural rearrangements, contrary to the common expectation of a completely arrested state [2,3]. In these systems, the dynamics evolves from a diffusive atomic motion in the supercooled liquid phase to a stress-dominated dynamics in the glass, characterized by a complex hierarchy of aging regimes. These finding present many similarities with the dynamics of various complex soft materials, like emulsions, gels and glassy colloidal suspensions [4] suggesting the existence of a common physical mechanism. Albeit this apparent universal out-of-equilibrium dynamics, an even more complex scenario emerges when the investigation is enlarged to other glasses. Measurements on sodium-silicate glasses show a surprising fast atomic motion, even hundreds degrees below the glass transition temperature [5]. In addition no aging of the dynamics is observed on experimental time scales of several hours, not even in the glass transition regions, in marked disagreement with macroscopic studies. This surprising stationary dynamics has been observed also in the case of metallic glasses but only for very large annealing times [2,3] and suggests the existence of a very peculiar relaxation dynamics at the atomic level, unaccounted for in previous experimental and theoretical works [1]. [1] L. Berthier and G. Biroli, Rev. Mod. Phys. 83, 587 (2011). [2] B. Ruta *et al.* Phys. Rev. Lett. 109, 165701 (2012). [3] B. Ruta *et al.* J. Chem. Phys. 138, 054508 (2013). [4] L. Cipelletti et al. Faraday Discuss. 123, 237, (2003). [5] B. Ruta *et al.* Nature Commun. 5, 3939 (2014).