	Experiment title: Atomic-scale dynamics in a sodium silicate glass former	**Experiment number**: HD548
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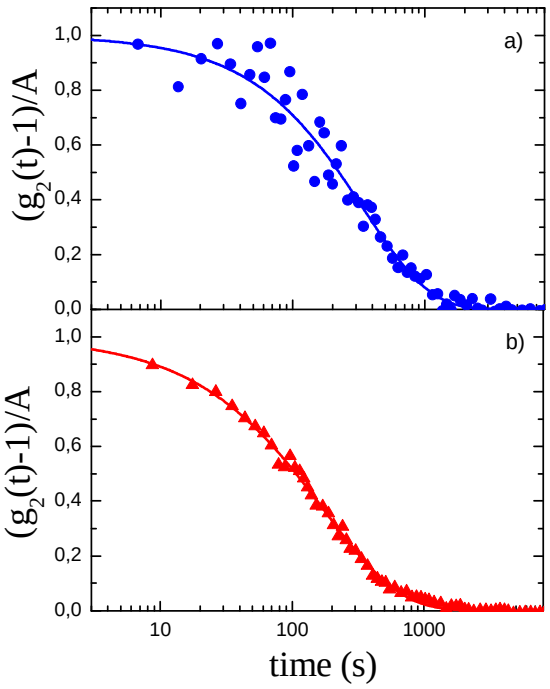
Report:

By means of X-ray Photon Correlation Spectroscopy (XPCS) we have measured for the first time the evolution of the structural relaxation process in a $0.8SiO_2 – 0.2Na_2O$ glass former in the glassy state (T_g=749 K). The measurements were carried out in a wide angle configuration by measuring the dynamics mainly for a wave vector Q, corresponding to the position of the first sharp diffraction peak in the static structure factor S(Q). In this way we have been able to look directly at the atomic dynamics, a task which is not reachable with any other technique.

The top panel of Figure 1 reports an example of the correlation functions measured in the glassy state by using a 2-dimensional CCD detector. The data are reported together with the best fit line shape obtained by using the Kohlraush-Williams-Watt expression $g_2(t)=1+Aexp(-2(t/\tau)^{\beta})$ where τ is the structural relaxation time, β the shape parameter and A the contrast factor. Due to the law scattering intensity of the sample, the data presents some noise, which leads to a large error bar of about 13% in the determination of the shape parameter β. Notwithstanding at all the investigate temperatures we found a stretched value β~0.8, close to the equilibrium liquid value reported in Literature (β_{liquid} (T_g)=0.63) , confirming the validity of our measurements.

In order to increase the statistics, a second CCD detector has been mounted, placed vertically with respect to the first one, which has allowed us to collect images corresponding to the same Q simultaneously on both the CCDs. The lower panel of Figure 1 shows a correlation curve measured at the same temperature by averaging the data obtained with the two CCDs. The improvement in the quality of the data allowed us to confirm the stretched behaviour of the correlation curved observed in the glassy state. Unfortunately, due to a technical

delay we could used the two CCDs configuration only in the last days of the experiment, while the majority of the measurements are taken with just one detector.



The slight difference in the decay time with respect to the one reported in upper curve (top panel) is simply due to the different thermal path used to reach this temperature. Indeed it is well known that the dynamics in the glassy state strongly depends on thermal history and waiting time and that the system slowly evolves toward the corresponding equilibrium liquid phase. A comparison with previously measured XPCS data on the microscopic dynamics in a metallic glass former, will give us the possibility to discriminate between universal and system dependent behaviour of the structural relaxation process in the glassy state. We are therefore confident that this experiment will strongly improve our knowledge on the dynamics of out of equilibrium systems.

Figure 1: *Normalized XPCS correlation functions measured at T=698 K with one (a) and two (b) CCD detectors.*

A study of the Q dependence of the structural relaxation time can therefore elucidate on the nature of different observed dynamics in the glassy state. During the experiment we have measured the dynamics also for few wave vectors Qs around the maximum of the first peak of the S(Q). The XPCS data seems to follow the shape of the S(Q) (De-Gennes narrowing), suggesting a diffusive nature of the dynamics in the glassy state. These data have been however taken by using just a single CCD detector which does not allow for a more accurate analysis of the β parameter which comes out to be almost constant within the error bars. A diffusive motion would be in agreement with the stretched behaviour of the correlation functions but it would of course require a more accurate study. It is then clear that the simultaneous use of two CCD detectors can strongly improve this kind of measurements allowing for a deeper and faster investigation of the Q dependence.