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Names and affiliations of applicants (* indicates experimentalists):

L. Börjesson, Dept. of Applied Physics, Chalmers Univ. of Technology, Göteborg, Sweden.

*A. Matic., Dept. of Applied Physics, Chalmers Univ. of Technology, Göteborg, Sweden.

D. Engberg, Dept. of Applied Physics, Chalmers Univ. of Technology, Göteborg, Sweden.

*C. Masciovecchio, Elettra Synchrotrone source, Trieste Italy

Report:

In this experiment we have investigated the dynamic structure factor S(Q,ω) at energies corresponding to below, at and above the Boson peak energy (E_{BP}) for the two glasses $Ca_{0.4}K_{0.6}(NO_3)_{1.4}$ (CKN) and Li_2O-$2B_2O_3$. The aim of the experiment was to study differences in the behaviour of collective excitations, and thus the dynamic structure factor for two glasses with very different intermediate range structures. CKN is an ionic glass with relatively weak inter-particle forces constants whereas Li_2O-$2B_2O_3$ is a modified network glass with strong covalent bonds between boron and oxygen and weaker ionic bonds between the Li-ions and the network. In previous IXS experiments we have found the existences of a linear dispersion relation for CKN up to 4 times the Boson peak energy (HS-195) whereas the dispersion relation for Li_2O-$2B_2O_3$ deviates considerably already below E_{BP} (HS-842). In the present work we have extended this study by performing Q-scans of the dynamic structure factor over a Q-range (0.5-35 nm^{-1}), not accessible by other techniques such as inelastic neutron scattering. In this way we cover both the brillouin region where we expect the contribution from acoustic modes and the region around the first sharp diffraction peak (FSDP) in the glasses.

The network glass Li_2O-$2B_2O_3$ was investigated at 7, 15 and 20 meV (E_{BP}=10 meV) at 700 K (T_g=770 K). In figure 1a the results for the inelastic scattering at the two energies are displayed. To obtain the spectrum data from 4 detectors were merged in the overlapping regions and the elastic contribution to the spectrum subtracted. The elastic scattering was determined from previously performed energy scans (HS-842). Below E_{BP} we clearly observe a brillouin peak in the low Q-region and at higher Q the intensity rises towards the first maximum of the structure factor (Q_{FSDP}=16 nm^{-1}). At the energies above E_{BP} the brillouin peak has vanished and the spectrum is quite featureless also at higher Q.

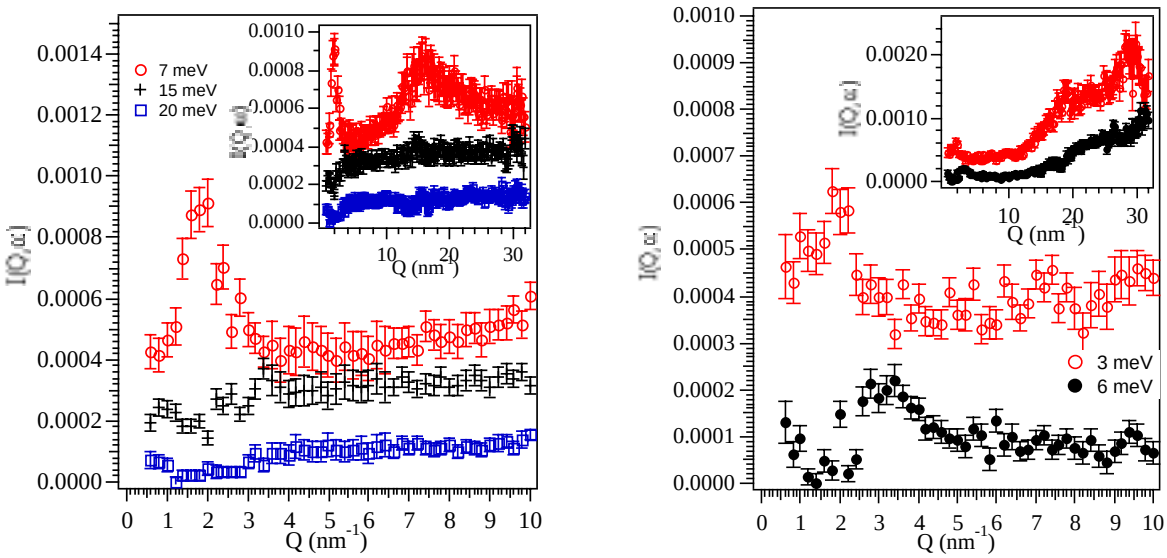

Figure 1. Dynamic structure factor in the Brillouin region at different energies. a) Li_2O-$2B_2O_3$ and b)CKN. The inset shows the full experimental Q-range. The spectra have been shifted vertically for clarity.

For CKN two energies were investigated 3 and 6 meV (E_{BP}=3 meV) at room temperature (Tg=330 K). To estimate the elastic contribution to the spectrum we also performed an energy scan. The results for CKN are shown in figure 1b. The behaviour in the brillouin region is in clear contrast to the situation in Li_2O-$2B_2O_3$. In CKN we not only see a brillouin peak at the Boson peak energy, but also at twice E_{BP}. The brillouin peak moves to higher Q at higher energies in agreement with the propagating nature of the excitation. At higher Q the intensity rises towards the first maximum of the static structure factor (Q_{FSDP}=19 nm^{-1}) at both energies.

The results clearly show how the propagating nature of the excitations in the low-Q region is lost in the network glass Li_2O-$2B_2O_3$ at energies above the Boson peak whereas it is preserved also at twice the Boson peak energy in CKN. The results from the final analysis will be discussed in relation to the strength of the Boson peak, structural differences on a meso-scopic length scale and current models regarding the dynamic in the Boson peak region.