Experiment title:

Long range density fluctuations in glass-forming liquids studied by USAXS

Experiment number:

Sc 90

Beamline:

BL4

Date of Experiment:

from: 24.8., 7°°h to: 28.8., 7°°h

Date of Report:

26.8.96

Shifts:

12

Local contact(s):

Peter Bösecke

Received at ESRF:
02 SEP 1996

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Report:

Static light scattering studies for glass forming liquids revealed that the scattering intensity I(q) at small q-values is much higher than the value expected from theory [1]. The excess scattering intensity is attributed to the existence of long range density fluctuations (LRDF), whose origin is not yet completely understood. The additional scattering might be an indication of a possible nonhomogeneous state of liquids in the vicinity of the glass transition, a hypothesis which has been discussed in the literature for a long time.

The aim of the experiment was a characterization of the scattering behaviour of glass forming liquids in the q-range between the range usually accessible by light scattering and the typical SAXS range as e. g. measured with a Kratky camera. Since in this latter range the expected height of scattering intensity corresponding to the isothermal compressibility is found, only an USAXS experiment with an extended q-range towards lower values should show the onset of the excess scattering and give its asymptotic q-dependence for higher q.

Measurements with several glass forming materials, i.e. the low molecular weight liquids OTP and BMMPC and the polymer PMPTS were made. Due to experimental problems which are mentioned in detail below, only in OTP (orthoterphenyl - a standard glass forming liquid) it was possible to identify the scattering contribution from the LRDF. The resulting curve is shown in figure 1. The asymptotic behaviour found in this measurement corresponds to Porod behaviour, $I(q)=q^{4}$, usually attributed to the existence of sharp interfaces between regions of different density in the sample. Indications for a temperature dependence of the excess scattering was be observed as well. Due to strong radiation damage an interpretation of the measurements in the polymer system PMPTS were not possible.

The experiment proved to be very difficult for several reasons. The scattering signal looked for is very weak in comparison to the instrumental background in the range of very small q. This background results mainly from scattering from windows and the sample cell (figure 2). Therefore an exact background subtraction is extremly difficult. Possible solutions to these problems are available, but could not be implemented during the experimental run this report is concerned with. The contribution from the sample cells can be reduced by using a sample holder with either very thin walls or without any walls. Cells with very thin walls have been tested, the scattering intensity can be reduced considerably. The instrumental background from beamline elements can be reduced by using a vacuum sample environment, without additional mica windows in front of and behind the sample.

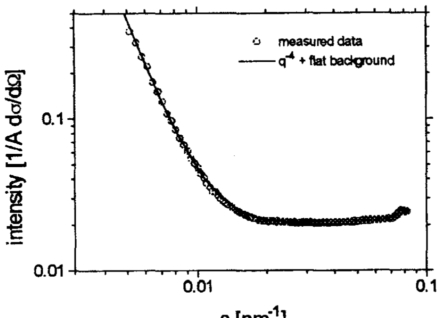
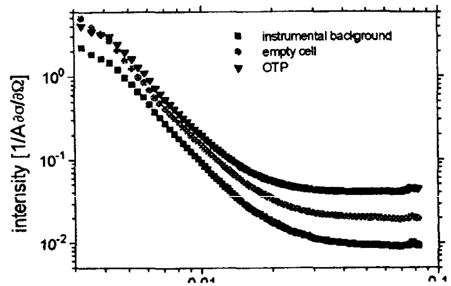


figure 1



references

1. E. W. Fischer, Physics A 201, 183 (1993)