EUROPEAN SYNCHROTRON RADIATION FACILITY

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ESRF

Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office using the **Electronic Report Submission Application:**

http://193.49.43.2:8080/smis/servlet/UserUtils?start

Reports supporting requests for additional beam time

Reports can now be submitted independently of new proposals – it is necessary simply to indicate the number of the report(s) supporting a new proposal on the proposal form.

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

Reports on experiments relating to long term projects

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

Published papers

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Deadlines for submission of Experimental Reports

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.

	Experiment title: Inhomogeneity and dynamics of the medium range order in polymer glasses – Pressure effect	**Experiment number**: HS 846
Beamline: ID16	**Date of experiment**: from: June 16, 1999 to: June 22, 1999	**Date of report**: Feb. 2001
Shifts: 18	**Local contact(s)**: C. Masciovecchio	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

Eugène DUVAL, L.P.C.M.L., Univ. Lyon I

Alain MERMET, E.S.R.F.

Report:

In the initial plan of the experiment, we had proposed to measure the inelastic X-ray scattering from polymer glasses under pressure, in continuation of a previous work done on PMMA glass (see experimental report HS197). In this latter investigation, we had evidenced a crossover pressure around 1.6 kbar, at which both the collective dynamics and the nanoscopic structural features of PMMA glass showed a change of regime in their pressure dependences (Phys. Rev. Lett., 80 (1998), 4205). These results were in agreement with the concept of non-inhomogeneity of the nanostructure of glasses (see for example Phys. Rev. B, 58 (1998) 8159), which actually motivated our first investigations on amorphous polymers.

In order to further test the relevancy of such concept, we attemped to measure the IXS of PMMA plasticized with dibutylphthalate (=DBP). Indeed, combined studies using Raman scattering and small angle X-ray scattering (Europhys. Lett. 44(1998) 747) had revealed that plasticizing PMMA with DBP molecules created a nanoscale heterogeneity while in the same time, increasing the boson peak intensity. Besides, S(Q) measurements of this system under pressure showed that the nanoheterogeneity of plasticized PMMA was significantly reduced increasing pressure. On the grounds of these observations, we considered that the investigation of the collective dynamics of this system under pressure would be very meaningful in our search aiming at establishing a relation between the meV excitations in glasses (boson peak) and the nanoscale glass inhomogeneity. Unfortunately, the very first IXS scans from plasticized PMMA revealed a very strong elastic peak (most likely associated with high small angle scattering) from which it turned out impossible to distinguish phonon lines. In the remaining allocated beamtime, we decided to investigate pure DBP under pressure, as DBP is known as an “intermediate” glass-former. Measurements were done at room temperature, i.e about 120K above the glass transition of DBP.

As an illustration of the obtained results, Figure 1a shows the inelastic scans of DBP at Q=2nm^{-1} as a function of pressure , while Figure 1b shows the inelastic scans at 4 kbar as a function of Q (= dispersing of the excitation). The sound velocity deduced from the dispersion relation E=f(Q) is of 2600 m/s, in agreement with Billouin light scattering data. As already found for other liquids and glasses, the width of the excitations displayed a Q^2 dependence, thereby indicating a structural disorder effect for which no satisfactory explanation has yet been found.

Fig. 1a

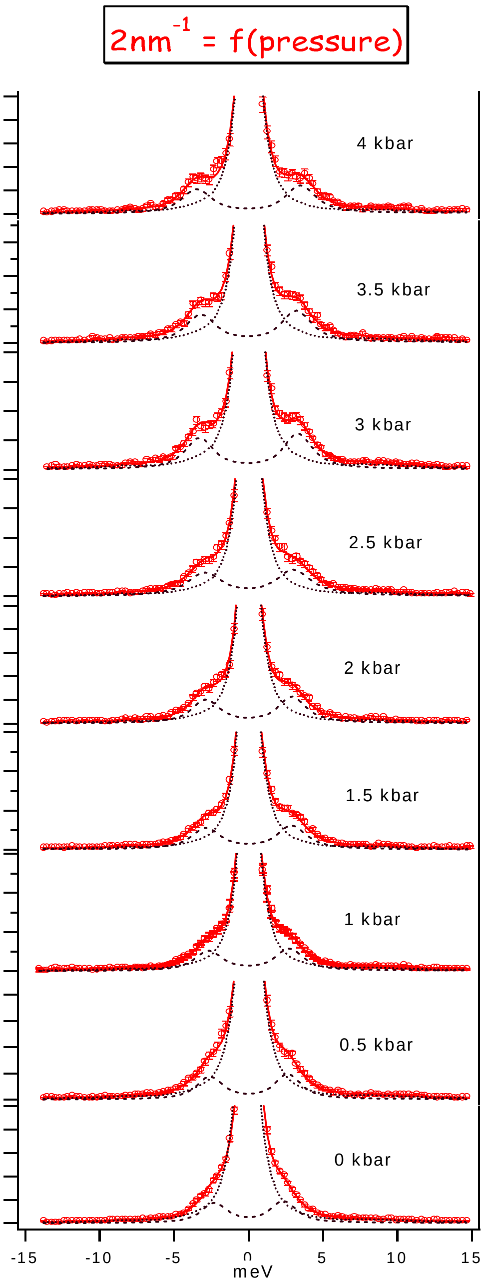
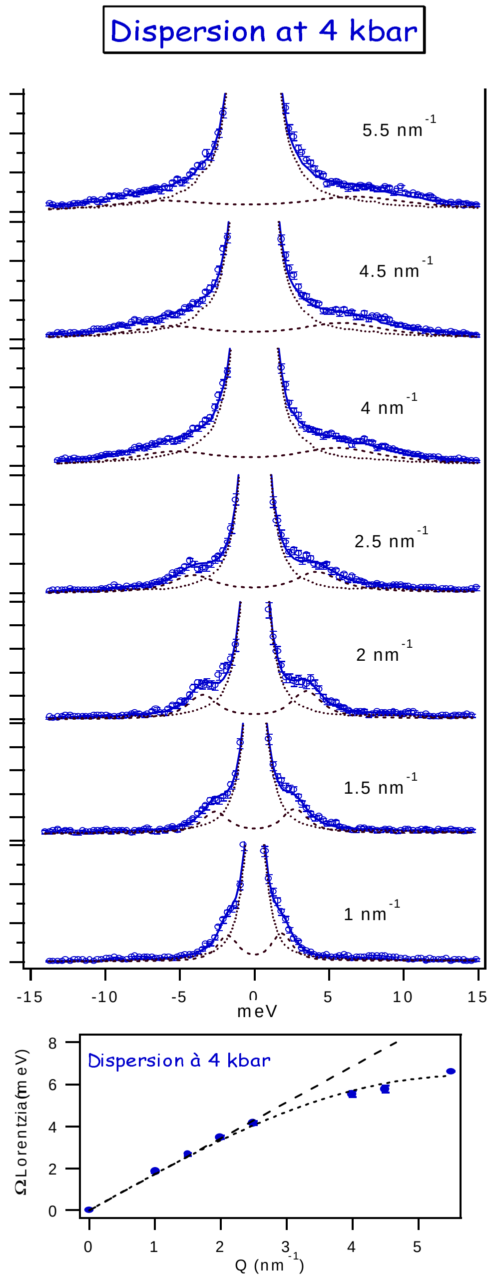


Fig. 1b



In order to complete the picture of the collective dynamics of DBP under pressure, we have performed Brillouin light scattering investigations in the same pressure range. Comparison of these latter data with the thereby reported IXS ones unveils an unexpected discrepancy between the two, in the low pressure regime (0 – 2 kbar). See attached proposal for further details.