EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

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 via the User Portal:
https://wwws.esrf.fr/misapps/SMISWebClient/protected/welcome.do

Deadlines for submission of Experimental Reports

Experimental reports must be submitted within the period of 3 months after the end of the experiment.

Experiment Report supporting a new proposal ("relevant report")

If you are submitting a proposal for a new project, or to continue a project for which you have previously been allocated beam time, you must submit a report on each of your previous measurement(s):

- even on those carried out close to the proposal submission deadline (it can be a *"preliminary report")*,
- even for experiments whose scientific area is different form the scientific area of the new proposal,
- carried out on CRG beamlines.

You must then register the report(s) as "relevant report(s)" in the new application form for beam time.

Deadlines for submitting a report supporting a new proposal

- 1st March Proposal Round - **5th March**
- 10th September Proposal Round - **13th September**

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.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report in English.
- include the experiment number 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.

<table>
<tr><td rowspan="1">ESRF</td><td>Experiment title: Study of glass transition and structural relaxation of metallic glasses under high pressure</td><td>Experiment number:
HC-3977</td></tr>
<tr><td>Beamline:
ID10</td><td>Date of experiment:
from: 3rd October 2018 to: 8th October 2018</td><td rowspan="2">Date of report:
2nd March 2020
Received at ESRF:</td></tr>
<tr><td>Shifts:
15</td><td>Local contact(s):
CHUSHKIN Yuriy</td></tr>
<tr><td colspan="3">Names and affiliations of applicants (* indicates experimentalists):
*Hongbo Lou, Center for High Pressure Science and Technology Advanced Research
*Qiaoshi Zeng, Center for High Pressure Science and Technology Advanced Research
*Zhidan Zeng, Center for High Pressure Science and Technology Advanced Research
*Xin Zhang, Center for High Pressure Science and Technology Advanced Research
*Tao Liang, Center for High Pressure Science and Technology Advanced Research
*Beatrice Ruta, Lyon 1 University</td></tr>
</table>

Report:

In the experiment HC-3977, we successfully performed the first in situ high-pressure XPCS experiments on a Ce-based metallic glass up to ~10 GPa using a diamond anvil cell at the beamline ID10. The XPCS data were collected at principle peak position (q_p) at given pressure points after the pressure was stabilized before the measurement. The time evolution of the microscopic dynamics during high pressure aging is captured in XPCS at q_p by the intensity two-time correlation function (TTCF), shown in Figure 1. At each pressure the relaxation time is stable in the whole time scale, indicating the stationary dynamics were measured at the given pressure. To get quantitative information of the relaxation process, the time average intensity auto-correlation functions, $g_2(q,t)$ are calculated, shown in Figure 2a, by averaging each TTCF along the t_w axis. In order to get the relaxation time and shape parameters, we use a modulated Kohlrausch-Williams-Watts (KWW) model function: $g_2(q,t) = 1 + a + c[\exp(-2(t/\tau)^{\beta})]$ to fit the $g_2(q,t)$ functions. Surprisingly, the relaxation time τ does not change monotonically with pressure, but it peaks at ~3 GPa, and then starts to decrease. The Ce-based MG has pressure-induced polyamorphic transition from low-density amorphous to high-density amorphous states. Interestingly, the pressure range where the τ changes anomalously well matches the polyamorphic transition zone in this MG detected by in situ high-pressure XRD measurements, as shown in Figure 2b. Our results reveal that microscopic dynamics may be highly susceptible to local atomic structures tuned by pressure. However, due to the limited beamtime and lack of sufficient experience for the first high pressure XPCS experiment both for us and the beamline scientists, we did not have chance to measure the reversibility/irreversibility of the behavior during decompression. Also, the pressure range is quite limited to have a clearer trend of the high pressure behavior. To address the mechanism behind, we need more tests on the same sample and also some other compositions to clarify the role of pure density change and electronic and atomic structure modification induced by pressure. Nevertheless, the present obtained results of the first high pressure XPCS experiment on metallic glasses are very interesting and the manuscript is under preparing.

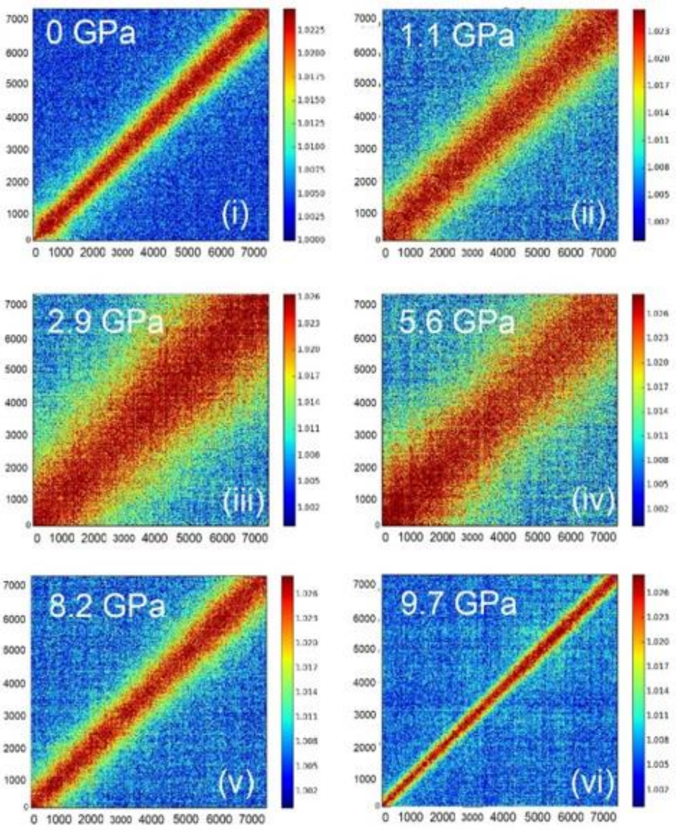

Figure 1. Two-time correlation function measured at different pressure. From the (i) to (vi), pressures are 0, 1.1, 2.9, 5.6, 8.2, 9.7 GPa, respectively.

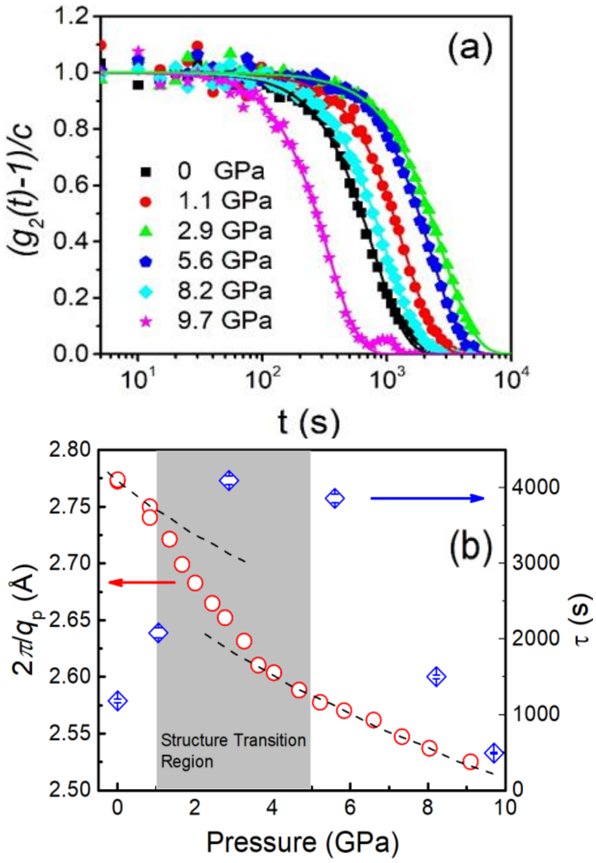

Figure 2. Pressure dependence of normalized correlation functions measured for q_p by means of XPCS on a Ce-based MG. (b) Pressure dependence of $2\pi/q_p$ and relaxation time τ measured by XRD and XPCS, respectively.