ESRF	**Experiment title:** Crystallization Kinetics in Bulk Metallic Glasses L 7 AOUT 2000	**Experiment number:** Me-72
Beamline: ID30	**Date of experiment:** from: May 4 to: May 12, 2000	**Date of report:** 15/Aug/00 *Received at ESRF:*
Shifts: 15	**Local contact(s):** Mohamed Mezouar	

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Report:

During our beamtime (15 shifts) in May, 2000, the effect of pressure on crystallization behavior of $Al_{89}La_6Ni_5$ metallic glasses has been studied in situ using angle-dispersive X-ray powder diffraction at beamline ID30. A large volume Paris-Edinburgh press and the FASTSCAN detector were used. The results obtained are briefly described below.

The partially crystallized Al-based metallic glasses exhibit novel mechanical properties much superior to that of conventional high-strength aluminium alloys, making this new family of Al-based metallic glasses to be a promising candidate as advanced engineering materials [1]. In the consolidation process, one of the fundamental issues is the pressure effect on thermal stability of the metallic glass. The effect of pressure on crystallization of an $Al_{89}La_6Ni_5$ metallic glass has been investigated by in situ high-pressure and high-temperature X-ray powder diffraction measurements using synchrotron radiation in the pressure range of 0-4 GPa [2]. Each run consists of an isothermal room-temperature compression followed by an isobaric heating to high temperature up to 673 K with a step of 10 K. The average heating rate in the temperature range from 298 to 673 K was roughly estimated to be 3 K/min. XRD patterns were recorded every 10 K in order to observe the onset temperature of crystallization within an uncertainty of 10 K in the pressure range of 0-4 GPa. It is found that the metallic glass crystallizes in two steps in the pressure range studied. The first crystallization process, corresponding to simultaneous precipitation of fcc-Al crystals and the metastable bcc-$(AlNi)_{11}La_3$-like phase, is governed by a eutectic reaction rather than a primary reaction suggested in the literature [3]. It should be mentioned that high quality XRD data recorded were essential to identify the new metastable bcc-$(AlNi)_{11}La_3$-like phase. The second one corresponds to the transformation of the residual amorphous alloy into fcc-Al and intermetallic compounds of $Al_{11}La_3$ and Al_3Ni. No room-temperature precipitation of fcc-Al crystals was observed in the XRD patterns recorded at pressures up to 4 GPa, which was contrary to the prediction reported in Ref. [3]. Figure 1 displays crystallization temperatures, T_{x1} and T_{x2}, of the $Al_{89}La_6Ni_5$ metallic glass as a function of the applied pressure. The applied pressure strongly affects the crystallization processes of the metallic glass, but not the crystalline phases formed, the sequence of phase formation and the temperature interval between two crystallization temperatures. T_{x1} and T_{x2} first decrease with pressure in the pressure range of 0-1GPa and then increase with pressure up to 4 GPa. The applied pressure has a similar effect on both crystallization processes in the pressure range studied, which is contrary to the previous proposal in which the applied pressure reduced the first crystallization temperature but enhanced the second crystallization temperature of the residual amorphous phase in the pressure range of 0-1 GPa [3]. Our results are discussed with reference to a model of competing processes of the thermodynamic potential barrier of nucleation and the diffusion activation energy under pressure.

Our project (ME-72) aims at the crystallization kinetics in bulk metallic glasses by automatically recording XRD patterns every 20-30 seconds using CCD detector. Unfortunately, during our beamtime, the CCD detector and the kinetic software were not available although we have constantly communicated with the local contact. Dr. Mohamed Mezouar told us that such problems should be solved in November 2000, by which the new CCD detector with kinetic software will be functioning. Thus, we need 15 shifts at the beamline ID30 after November, 2000 to perform the experiments required in our project: Crystallization kinetics in bulk metallic glasses.

1 H. Chen, Y. He, G.J. Shiflet, and S.J. Poon, Nature **367**, 541 (1994); and A. Inoue, Progress in Materials Science **43**, 365 (1998).

2 Y.X. Zhuang, J.Z. Jiang, T.J. Zhou, H. Rasmussen, L. Gerward, M. Mezouar, W. Crichton, and A. Inoue, submitted to Appl. Phys. Lett.

3 F. Ye and K. Lu, Acta Mater. **47**, 2449 (1999); Phys. Rev. B. **60**, 7018 (1999); and J. Non-crystal. Solids **262**, 228 (2000).

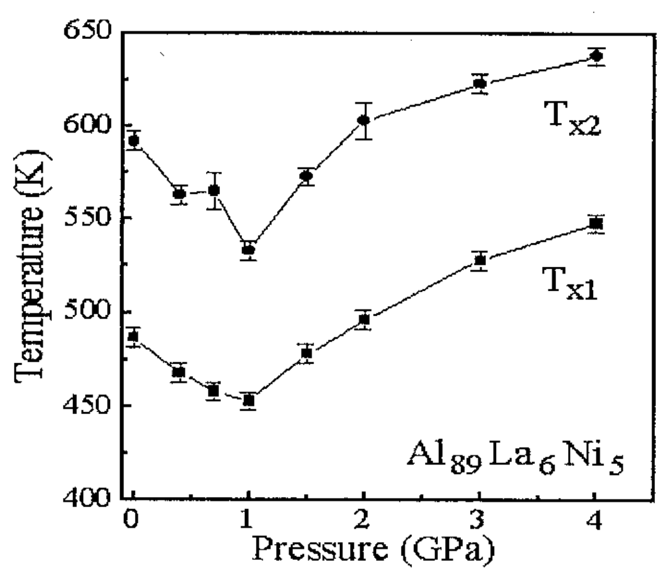

Fig. 1 Pressure dependences of the crystallization temperatures estimated from in situ high-temperature and high-pressure X-ray powder diffraction measurements for the $Al_{89}La_6Ni_5$ metallic glass.