ESRF	**Experiment title: Deformation induced crystallization of metallic glasses**	**Experiment number**: HD-71
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Shifts: 6	**Local contact(s)**: Dr. Jonathan P. Wright	*Received at ESRF:*

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Report:

Metallic glass samples with composition of $Al_{85}Ce_8Ni_5Co_2$, $Al_{85}Y_8Ni_5Co_2$, $Cu_{60}Zr_{40-x}Ti_x$ (x=10, 20, 30) $Zr_{44}Ti_{11}Cu_{10}Ni_{10}Be_{25}$ and $Zr_{57}Ti_5Cu_{20}Al_{10}Ni_8$ subjected to severe plastic deformation by high pressure torsion (HPT) were investigated by the high energy stability XRD synchrotron beam of the ID11 beamline of 10μm x 10μm beam size at 90keV. Additionally, XRD spectra were collected from undeformed, thermally/thermo-mechanically crystallized metallic glass samples of same kind for comparison.

HPT deformed $Al_{85}Ce_8Ni_5Co_2$ and $Al_{85}Y_8Ni_5Co_2$ samples show similar behaviour regarding the formation of the fcc-Al phase. In HPT disk of the $Al_{85}Y_8Ni_5Co_2$ glassy ribbon, gradual appearance of the fcc-Al phase was observed with increasing radius/strain started from about 2/3 radius of the sample. However, changes of the thermal signal in HPT disk was observed even in the center of the disk. The width of the fcc-Al Bragg peaks was constant for different radia (Figure 1) [1].

In the $Cu_{60}Zr_{10-30}Ti_{30-10}$ alloy series, the deformation sensitive $Cu_{60}Zr_{-30}Ti_{10}$ composition was investigated in details. Crystal formation and break up of the formed large (about 20μm size) blocks into nanocrystals and mixing of these blocks into a homogeneously dispersed nano-phase was observed by synchrotron X-ray diffraction and TEM study with increasing deformation. The change from the amorphous phase to the nano-crystalline mixture is correlated by a shift in the closes atomic positions in the radial distribution function [2].

Bulk metallic glasses ($Zr_{44}Ti_{11}Cu_{10}Ni_{10}Be_{25}$ and $Zr_{57}Ti_5Cu_{20}Al_{10}Ni_8$) showed no trace of the crystal formation even after severe plastic deformation of 125 shear strain. This indicates large stability of this BMG alloys against crystallization. By the advent of the high energy stability beam, shift of the halo position was

measured at different positions along the radius and one of the cross-sections of the HPT disk. Evaluation of XRD patterns from different direction in the sample revealed an anisotropy in the shifts of the halo position i.e. in the metallic glass (Figure 2) [3-5].

[1] P. Henits, Zs. Kovács, A. P. Zhylaev and Á. Révész, "X-ray diffraction study and thermal characterization of high-pressure-torsioned $Al_{85}Y_8Ni_5Co_2$ amorphous alloy" J. of All. and Comp. accepted
[2] S. Hóbor, Á. Révész, P. J. Szabó, A. P. Zhilyaev, V. K. Kis, J.L. Lábár and Zs. Kovács, "High pressure torsion of amorphous $Cu_{60}Zr_{30}Ti_{10}$ alloy" submitted to J. Mater. Res.
[3] Zs. Kovács, E. Schafler and Á. Révész, "High pressure torsion of bulk metallic glasses" poster presentation at the ISMANAM 2007, Corfu , Greece
[4] Zs. Kovács, F Qods, J. Lendvai and L. S Tóth, "Plastic deformation of metallic glasses in torsion" oral presentation at the ISMANAM 2007, Corfu , Greece
[5] Á. Révész, E. Schafler and Zs. Kovács, "Anisotropy in HPT deformed bulk metallic glass" to be submitted to Appl. Phys Lett.

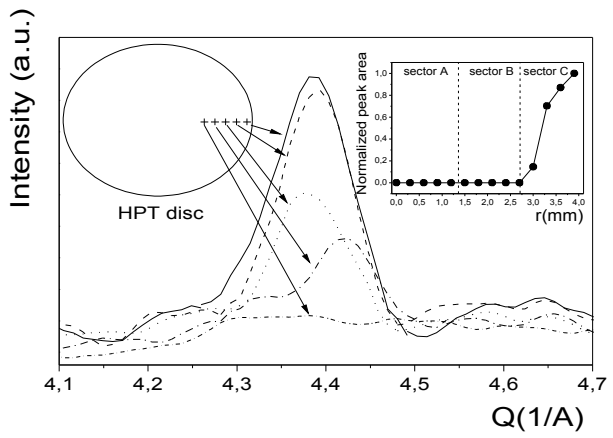

Figure 1: Section of the XRD spectra collected on $Al_{85}Y_8Ni_5Co_2$ HPT disk (as indicated in the inset). Area of the fcc-Al peaks are also plotted in the insert.

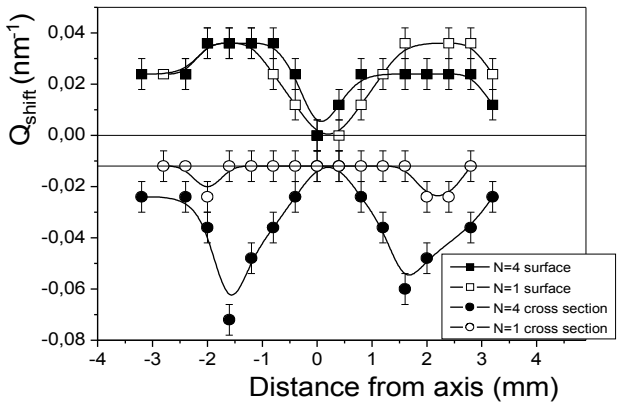

Figure 2: Shift of the amorphous XRD halo position of HPT deformed $Zr_{57}Ti_5Cu_{20}Al_{10}Ni_8$ BMG disks for perpendicular sections of the disk for N=1 and 4 rotations.