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Report:

In this experiment, we have studied the effect of ion irradiation on structural and magnetic stability of amorphous metallic glasses (MGs). The following compositions were investigated: $^{57}(Fe_3Co_1)_{76}Mo_8Cu_1B_{15}$, $^{57}Fe_{76}Mo_8Cu_1B_{15}$, $^{57}Fe_{90}Zr_7B_3$, and $^{57}Fe_{81}Mo_9Cu_1B_9$. All samples were enriched in ^{57}Fe to ~50 % in order to enhance the sensitivity of detection.

As-prepared (as-quenched) and ion irradiated MGs were subjected to ***in-situ*** temperature treatments during nuclear forward scattering (NFS) experiments. Samples were in a form of ribbons that were prepared by rapid quenching on a rotating wheel. Due to the way of preparation, both sides of the ribbons are different. The side which was in direct contact with the quenching wheel is called *wheel side*; the opposite one which was exposed to the surrounding atmosphere is called *air side*. Ion implantation was performed with N^+ ions with the energy of 130 keV to the air side with the total fluencies of up to 2.5×10^{17} ions/cm^2. The maximum penetration rage of the N^+ ions is ~150 nm as obtained from the SRIM calculations and confirmed by CEMS (Conversion Electron Mössbauer Spectrometry) measurements [1, 2].

NFS experiments were realized as isothermal scans at various temperatures in a vicinity of the onset of the crystallization temperature. These values were determined from dynamical temperature scans that were performed with the ramp of 10 K/min. The recording time of one scan was 60 s, in total up to 130 scans were acquired during one *in situ* heating cycle. The aim was to look for the kinetics of crystallization in structurally modified (ion irradiated) samples in comparison with the as-quenched ones.

Some of the obtained results are shown in Fig.1 where isothermal time scans (T = 300 ^{o}C) are presented for the $^{57}Fe_{81}Mo_9Cu_1B_9$ MG irradiated with 2.5×10^{17} N^+/cm^2. They are displayed as contour plots. Vertical axes represent the time of isothermal annealing (number of scans) while the elapsed time after nuclear excitation is given on the horizontal axes (in channels). The counts of the registered photons (intensities) are plotted in a logarithmic scale.

Notable differences are seen between the air and the wheel sides of the ribbon which were during the experiment oriented towards the synchrotron beam. At the air side, which was exposed to ion bombardment, the time evolution of the NFS signal is faster than at the wheel side. It is stabilized after about 15 min of the experiment while at the wheel side more than 25 min are needed. In addition, the character of the beating also deviates. In order to describe the observed features, evaluation of the individual NFS interferograms is inevitable. As we have shown in our previous studies, structurally different regions contained in the investigated nanocrystalline alloys can be identified [3, 4].

(a) (b)

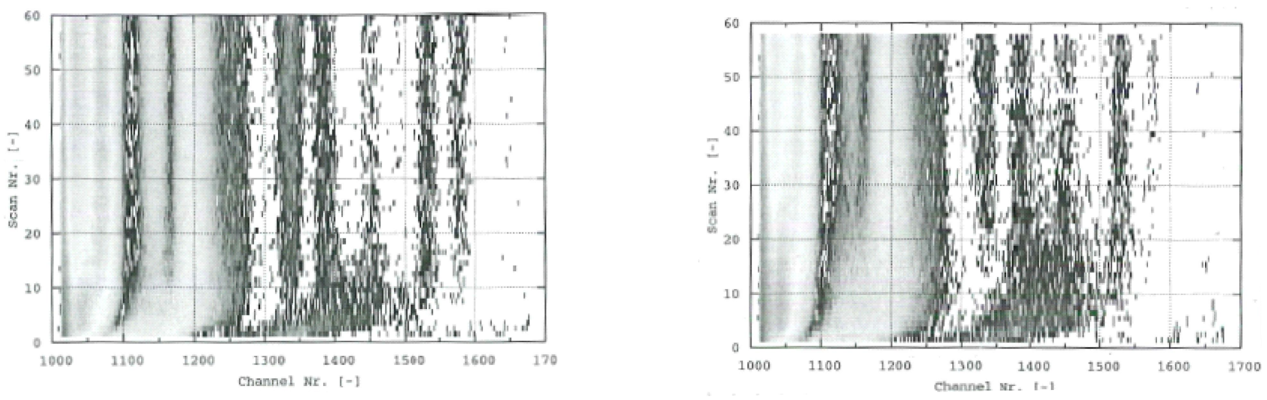

Fig. 1. Isothermal NFS scans (@ 300 °C) corresponding to the air (a) and wheel (b) side of the $^{57}Fe_{81}Mo_9Cu_1B_9$ MG irradiated with the fluence of 2.5 x 10^{17} N^+/cm^2.

The effect of ion fluence upon structural modification of the same alloy is demonstrated in Fig. 2. Again, striking differences between both sides of the ribbon are clearly visible. In addition, comparing the results presented in Fig. 1 and Fig. 2, deviations between higher (2.5 x 10^{17} N^+/cm^2) and lower (2 x 10^{16} N^+/cm^2) fluence affecting the same side of the ribbon can be distinguished.

(a) (b)

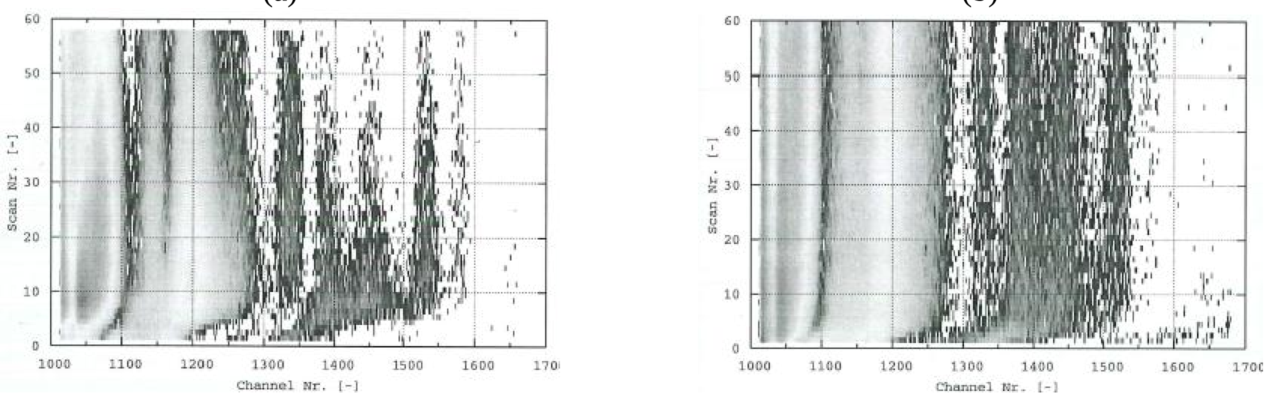

Fig. 2. Isothermal NFS scans (@ 300 °C) corresponding to the air (a) and wheel (b) side of the $^{57}Fe_{81}Mo_9Cu_1B_9$ MG irradiated with the fluence of 2 x 10^{16} N^+/cm^2.

Similar results as shown for the $^{57}Fe_{81}Mo_9Cu_1B_9$ MG were obtained for the rest of the measured alloys. Evaluation of the obtained results (ca. 2 000 records) is still in progress.

References:

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