Effects of swift heavy ion irradiation on structural and magnetic properties for metallic glasses

Jianrong Sun[1], **Zhiguang Wang, Yuyu Wang**

Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou, 730000, Gansu,China

Synopsis The effects of high energy Kr^{26+} ions irradiation on metallic glass FeSiNbZrB ribbons are reported. Before and after irradiation, neither metallic glass systems show long-range order in atomic arrangement, but both exhibit only a short-range order. And under irradiation, there was little decrease in reflectivity of the metallic glass FeSiNbZrB, showing its high resistance to swift heavy ion irradiation.

Metallic glass (also known as amorphous alloy) is a kind of new alloy material synthesized by using modern rapid solidification metallurgical technology, owning excellent mechanical, physical and chemical properties that general metal and glass have [1]. Along with the in-depth research and development of metallic glass material, two fundamental but not yet answered scientific questions inevitably lay in front of us: what are the mechanisms of the relaxation behavior as well as the plastic deformation of the metallic glass? Existing research on metallic glass show that the processes of relaxation and plastic deformation seem to be totally different, but essentially they are the same, both being the reactions of glass to the external energies (e.g. temperature, force, pressure, etc.) [2]. Therefore, in our experiment, swift heavy ion (SHI) irradiation as a kind of special non-equilibrium and exogenous energy deposition process will be applied to the study on the mechanisms of relaxation and plastic deformation of the metallic glass.

Amorphous FeSiNbZrB alloy ribbons were prepared by melt spinning and SHI irradiation experiments were performed on the materials research terminal of the HIRFL-SSC (IMP, Lanzhou). In experiment, the amorphous ribbons were irradiated at RT with 2.01 GeV Kr^{26+} ions for fluence from 1×10^{11} to 1×10^{14} ions/cm^2.

From results of structural and magnetic measurements, it's obviously that after irradiation, all the ribbons remain amorphous and magnetic anisotropy considerably changes from its original in-plane direction. In fact, MS reveal that in a substantial volume fraction of the irradiated samples the spins changed their orientation from the in-plane orientation to the perpendicular one. This effect can be attributed to the formation of cylinders structure along the ion path which may induce a stress as a result of which a substantial fraction of spins are aligned along the beam direction, i.e. perpendicular to the plane of the sample. In addition, the irradiation has caused a significant increase of the isomer shift due to changes in topological and chemical short-range order (SRO), and a distribution of hyperfine magnetic field of the irradiated sample, show a small but distinct peak at 11.5 Tesla, corresponding to the Fe-B pairing.

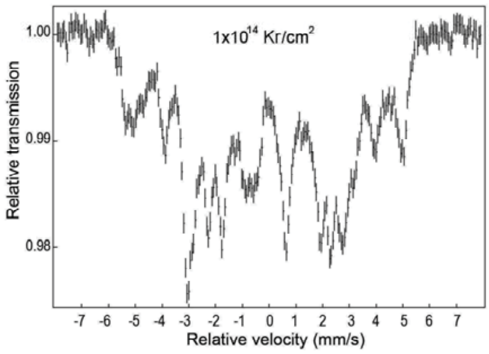

Figure 1. The mössbauer spectra at RT for the irradiated FeSiNbZrB ribbons.

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References

[1] H.W. Sheng *et al* 2006 *Nature* **439** 419.
[2] W.H. Wang *et al* 2004 *Mater. Sci. Eng. R* **44** 45.

[1] E-mail: sunjr@impcas.ac.cn