Modification of metallic glasses with swift heavy ion irradiation

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Ions at energies of some MeV per nucleon lose their energy mainly to the electronic system near the ion path when they pass through matter. Energy transfer from the electronic system to the atoms due to electron-phonon coupling may finally lead to the formation of long columnar defects along the ion trajectories. Such ion tracks have been observed in numerous insulators and a number of semiconductors [1, 2]. Metallic materials are in general less sensitive to ion track formation due to their high electron mobility, with the exception of a few selected metals (e.g. Bi, Zr, Ti) and various metallic glass alloys.

Ion tracks are often characterized only by subtle differences in structure and density between track and matrix material. This lack of contrast leaves the complex structure of ion tracks inaccessible with most experimental techniques. At present, there is little information about the effect ion tracks in metallic glasses. We have been able to characterize the morphology of ion tracks produced in metallic glasses using synchrotron based small angle x-ray scattering (SAXS) [3]. The SAXS scattering intensities originating from the ion tracks were fitted employing a simple cylindrical model assuming constant density in the track, different from that of the matrix material. The annealing kinetics of the ion tracks have been studied with small and wide angle x-ray scattering, characterizing the track recovery while the material still is amorphous. Annealing below the recrystallisation temperature prior to irradiation leads to smaller track sizes than in the unannealed sample. The observed reduction in track radii upon pre-irradiation annealing is likely a consequence of a relaxation of the material and a possible means of increasing the radiation resistance of such materials. In this presentation we will discuss our recent findings on ion track formation in Fe-B based metallic glasses upon annealing before and after heavy ion irradiation and the implications in their mechanical properties.

[1] M. Toulemonde *et al.*, Matematisk-fysiske Meddelelser **52** (2006) 263.
[2] S. Klaumünzer, Matematisk-fysiske Meddelelser **52** (2006) 293.
[3] M. D. Rodriguez *et al.*, J. Non-Cryst. Sol. **358** (2012) 571.