Effects of Neutron Irradiation on Properties of Iron Pnictide Superconductors


Introduction

Neutron irradiation is a powerful tool for theoretical studies as well as for the optimization of superconductor properties, since electron scattering centers and/or flux pinning sites are introduced. Fast neutrons introduce atomic disorder and in many cases flux pinning efficient defects. Fe-based superconductors offer promising superconducting properties. We report the influence of atomic disorder introduced by sequential neutron irradiation on the superconducting properties and flux pinning in polycrystalline SmFeAsO1-xFx (Sm-1111) and single crystal BaFe1.8Co0.2As2 (Ba-122).

Experimental

Polycrystalline SmFeAsO1-xFx (Sm-1111) and single crystal BaFe1.8Co0.2As2 (Ba-122) samples were prepared at the National High Magnetic Field Laboratory. Neutron irradiation was performed in the central irradiation facility of the TRIGA-Mark-II reactor at the Atomic Institute in Vienna. The samples were sealed into a quartz tube and irradiated sequentially, starting with a fast neutron fluence (E > 0.1 MeV) of 4x10^{21} m^{-2}. The highest cumulative fluence was 1.8x10^{22} m^{-2}. The electromagnetic properties of the samples were characterized before and after the neutron irradiation.

Results

An obvious increase in resistivity after the irradiation was observed in both compounds, in single and polycrystals. As shown in Fig. 1, the disorder introduced by irradiation decreases Tc for both Sm-1111 and Ba-122 samples with a similar slope dTc/dF. Magnetization loops at various temperatures were measured by SQUID and VSM magnetometers. The magnetization critical current densities generally increase after the first irradiation step (fast neutron fluence: 4x10^{21} m^{-2}), but starts to decrease again upon further irradiation in the Ba-122 single crystal, while a further improvement up to a fluence of 1.8x10^{22} m^{-2} was found at high fields in Sm-1111.

Conclusion

A monotonic decrease of the transition temperature with neutron fluence degrades the upper critical field, at least at high temperatures, in both Sm-1111 and Ba-122. Pinning on the other hand is largely improved, with a different optimal defect concentration (fluence) in the two materials.

Acknowledgements

Work at NHMFL was supported under NSF Cooperative Agreement DMR-0084173, by the State of Florida, and by AFOSR grant FA9550-06-1-0474.

References