Peak Effects in Heavy-ion Irradiated $NbSe_2$

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Columnar defects (CDs) created by heavy-ion irradiation are very effective in enhancing the critical current density (J_c) in superconductors. Such an enhancement of J_c was first demonstrated in cuprate superconductors [1], and similar enhancements of J_c was reported in conventional [2] and iron-based superconductors [3]. However, how the enhancement of J_c occurs depends strongly on the materials, energy and density of heavy-ions, and configuration of CDs, parallel or splayed (having angular dispersions). In some cases, J_c is monotonically enhanced, while in other cases, non-monotonic magnetic field dependence of J_c, peak effect, is observed after the introduction of CDs. The mechanism for the peak effect in superconductors with CDs is still unclear as well as the peak effect in pristine superconductors. For example, a novel peak effect is observed at ~1/3B_Φ (B_Φ: matching field) in (Ba,K)Fe_2As_2 when CDs are introduced from two directions at $\pm\theta_{CD}$ from the *c*-axis [4]. Recently, a similar peak effect at some fraction of B_Φ has been reported in $NbSe_2$ with CDs tilted 30° from the *c*-axis [5]. In this talk, we present a systematic study on magnetic field dependence of J_c in $NbSe_2$ with CDs created by 320 MeV Au and 800 MeV Xe irradiations. Depending on the ion species and/or its energy, two kinds of peak effects are observed when the CDs are introduced in a splayed manner. The peak field B_p in both cases depends strongly on θ_{CD} and its behavior is different from that found in (Ba,K)Fe_2As_2 with splayed CDs. We summarize the condition for the peak effect and its behaviour, and discuss possible origin.

References

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