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Enhancing Flux Pinning by Heavy-Ion Irradiation in High-Temperature Superconductors

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The critical temperatures of high-temperature superconductors (HTS) are much higher than the liquid-nitrogen temperature, however, their current carrying capability is quite low. The most important reason is the layered structure of HTS. Most of HTS have the superconducting Cu-O layers separated by the insulating or normal layer. When external magnetic fields are applied perpendicular to the Cu-O planes, the vortex structure consists of two-dimensional (2D) vortices in the Cu-O layers weakly interacting with the other 2D vortices in the adjacent layers. Thus the ordinary flux pinning by point defects is quite small compared to the conventional superconductors since the pinning effect by the point defects is limited to the individual 2D vortices that reside at the defect locations. One useful method to overcome the weak pinning effect by point defects is introducing linear defects in the samples, and it can be done by using the heavy-ion irradiation to form the linear defects in HTS. Highly energetic heavy ions with kinetic energies in the range of 1 GeV give their energies to the atoms on the way by inelastic collision, thus forming the linear column-shape amorphous tracks which can be very efficient pinning centers. These columnar defects can pin all the 2D vortices in their tracks so that the flux pinning property is greatly enhanced. In this talk, we will review the important findings in the field of heavy-ion irradiation in HTS.

Keywords : Heavy-ion irradiation, high-temperature superconductor, columnar defects, 2D vortex, flux pinning