J_c Anisotropy Analysis in YBCO Coated Conductors: Hybrid APC Effect and Modelling Using 3D Time Dependent Ginzburg-Landau Equations

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Abstract - In type-II superconductor, energy dissipation is associated with the motion of vortex lattice in a form of vortex flow or creep. This dissipation is reduced by the presence of crystalline defects, namely "pinning". An important technological challenge in application of type-II superconductors is increasing J_c under magnetic field. Epitaxial YBCO films having compound defects such as continuously developed $BaZrO_3$ (BZO) and $BaSnO_3$ (BSO) nanorods parallel to the c-axis of the films show the c-axis correlated, Bose-glass behavior. Significant enhancement of irreversibility field $B_{irr}(T)$ and critical current density J_c is also observed particularly when magnetic field is applied parallel to the c-axis of the films (B | | c). Firstly, in this presentation, the present situation of vortex pinning technology in YBCO superconducting films is reviewed, especially focusing on a new approach of hybrid APC technique. The detailed particular of the depinning of vortices from the pinned state are complex, involving the non-equilibrium dynamics of an elastic lattice through a disordered medium. Numerical simulation study of vortex dynamics by solving the time-dependent Ginzburg-Landau (TDGL) equations, where the vortex-vortex and vortex-pinning interactions are completely characterized, is effective approach to reliably describe the details of complex pinning-depinning transition. Secondary, we demonstrated the use of the method by solving a fully three dimensional problem of a current carrying superconductors with columnar defects such as nanorods under the tilting magnetic fields. The complex pinning-depining transition in the vicinity of nanorods will be visualized based on the TDGL calculation.

Keywords (Index Terms) - YBCO coated conductors, artificial pinning centers, vortex pinning and motion, time-dependent Ginzburg-Landau equations.