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Wed-Mo-Po.03-03: Critical current and magnetic flux transport in 2G HTS wires with an artificial pinning landscape caused by a fractal percolation structure

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The effect of pinning landscape on critical current in percolative HTS composites is studied. The superconductor contains percolative superconducting cluster carrying a transport current, and artificial pinning centers created by normal-phase fractal clusters. Such a structure provides for effective pinning and thereby raises the critical current because the magnetic flux is locked in finite clusters of a normal phase, and so the vortices cannot leave them without crossing the surrounding superconducting space. The normal-phase clusters have fractal boundaries and this feature exerts an appreciable effect on vortex dynamics. Any movement of magnetic flux causes energy dissipation in superconductors therefore the method of suppressing such movement is of great practical importance. The influence of vortex percolation in the course of flux flow and flux creep on the critical current for different values of fractal dimension of normal-phase clusters is analyzed. Various modes of creep are considered. The resistive characteristics of percolative superconductors in the presence of the pinning landscape with fractal pinning centers are obtained. Electric field induced by vortex motion is analyzed and the critical current value is estimated. It is found that the existence of fractal boundaries between normal and superconducting phases intensifies pinning and suppresses the electric field. The use of normal-phase fractal clusters as pinning centers provides an additional opportunity to increase the critical current, since the structural irregularities of such objects with fractional dimensions span a wide range of geometric sizes, up to the vortex core diameter, which ensures effective pinning. The current-carrying capability can be increased by creating such a pinning landscape that could simultaneously provide creep suppression both in Anderson-Kim and collective creep modes. Correlated defects, such as clusters of columnar defects, can be used to suppress Anderson-Kim creep, while collective creep can be suppressed by randomly distributed point defects. In order to create such a combined pinning landscape, PLD (Pulsed Laser Deposition) technology in combination with ion irradiation, can be used. Results apply to YBCO coated conductors for use in superconducting magnet windings.

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