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Magnetic flux trapping and creep in 2G HTS wires containing normal-phase fractal clusters

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The effect of the magnetic flux trapping in normal-phase fractal clusters on critical currents in percolative HTS composites is studied. The normal-phase clusters are united by the common trapped flux and surrounded by the filling superconducting phase. The superconducting phase fraction is above the percolation threshold so there is a superconducting percolation cluster which is carrying a transport current. The normal-phase clusters have fractal boundaries so their structural irregularities span a wide range of geometric sizes, up to the vortex core diameter. The latter feature makes pinning on such defects effective. Since any motion of magnetic flux causes energy dissipation in superconductors, a method to suppress such motion is of prime practical importance. The effect of flux creep on the critical currents for different values of fractal dimension of normal-phase cluster is analyzed. The modes of collective creep as well as Anderson-Kim creep are considered. The current-voltage and resistive characteristics of percolative superconductors in the presence of the flux creep are obtained, and the critical current values are estimated. The dependence of the resistive characteristics of superconducting composites containing normal-phase fractal clusters on the pinning barrier biasing by the transport current has been established. It is found that the existence of fractal boundaries between normal and superconducting phases intensifies the magnetic flux trapping and suppresses the electric field induced by creep. This feature enhances the current-carrying capability of a superconducting wire. Results apply to YBCO coated conductors for use in superconducting magnet windings.

Primary author: Dr KUZMIN, Yuri (Ioffe Physical Technical Institute of the RAS)

Presenter: Dr KUZMIN, Yuri (Ioffe Physical Technical Institute of the RAS)

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