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# Superconducting Fractal Multilayers

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## Abstract

The influence of fractal geometry on superconductivity has been studied for layered superconductors. Superconducting multilayers consisting of alternating Nb and Cu layers with fractal stacking sequence and fractal dimension Df=0.63 including the two limiting cases Df= 0 (single superconducting film) and Df=1 (periodic multilayers) were prepared by electron-beam evaporation in ultrahigh vacuum. The layers of Nb and Cu were put down alternately via computer control of the target shutter. The structure of the samples has been checked with in situ reflection high-energy electron diffraction (RHEED) and Auger depth profiling, confirmed the prescribed layering geometry. Superconductivity was investigated by measurements of the critical temperature of superconducting transition Tc, and of the temperature and of the angular dependence of the upper critical magnetic fields Bc2. The observed dependences of Tc on the parameters of fractal samples are in a good qualitative agreement with the proximity effect theory developed for layered superconductors with a self-similar fractal structure. The behavior of the upper critical magnetic field is directly related to the type of the layering. At low temperatures, all samples show the same two-dimensional behavior essentially governed by the topological dimension of the individual superconducting layers, independent of the fractal dimensionality Df of the samples, whereas for temperatures near Tc the type of layering determines the dimensionality, resulting


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in a multicrossover behavior of fractal samples. The angular dependence of the upper critical magnetic field $Bc2(\theta)$ of fractals corresponds to the theory for a two-dimensional superconductor at all temperatures, reflecting the multicrossover behavior of the fractal multilayers, as long as the temperature-dependent coherence length is comparable with a certain scale of fractal.