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Critical currents and fields of disordered nanocrystalline superconductors

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There is an enormous effort directed at increasing the upper critical field of the superconducting materials because this upper critical field provides a fundamental limit to the maximum field a magnet system can produce. High-energy particle accelerators and medical resonance imaging body scanners are limited by the for NbTi (10 T). Gigahertz class nuclear-magnetic-resonance and high field laboratory magnets are limited by for Nb3Sn (23 T) [1].

However, the values of critical current density are too low for industrial use, possibly because of degraded or nonsuperconducting phases, such as MoS2 or Mo2S3, at the grain boundaries or because the pinning site density is not high enough. It has long been known that decreasing the grain size of low-temperature superconducting (LTS) materials, such as Nb3Sn, increases the density of flux pinning sites and hence .

Nanocrystalline materials are characterized by ultrafine grains and a high density of grain boundaries [2]. Hence nanocrystalline materials can exhibit unusual physical, chemical, and mechanical properties with respect to conventional polycrystalline materials.

The porpose of this paper is to investigate,the structure of currents and fields in disordered nanocrystalline superconducting materials by the use of quasiclassical many body techniques. The Keldish Greens functions are used to calculate the current density of the system.

Since the disorder and microstracture of these nanocrystiline materials are on a sufficiently short length scale as to increase both the density of pinning site and the upper critical field.

[1]: H. Krauth, Handbook of Applied Superconductivity edited by B. Seeber (IOP, London, 1998), Vol 1, P, 397.
[2]: H. Gleiter, Acta Mater. 48, 1 (200).