MASTER DE PHYSIQUE ET APPLICATIONS - 2ème **année**

Spécialité Sciences des Matériaux et Nano-objets

International Nanomat Master Program

Internship proposal 2010-2011

Laboratory : Superconductivity and microwaves

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Directional pinning of flux lines in nanostructured superconductors: a very-high-frequency experimental study.

Scientific project :

Pinning of flux lines is an essential issue for practical applications of superconductors, in order to avoid the insurgence of losses due to the flux motion.

In high-Tc cuprates, this is a major issue: intrinsic properties (high operating temperatures, large anisotropy, small coherence length) conspire to make flux lines very flexibles and hard to pin.

Recently, it has been discovered that specific inclusions (e.g., $BaZrO_3$) in the target from which films are grown, once deposited in the superconducting film, can self-assemble in the shape of quasi-columnar defects. This feature led to a very significant increase of the irreversibility line in $YBa_2Cu_3O_7/BaZrO_3$ thin films.

However, directionality of such pinning sites poses several questions on both practical use and fundamental aspects of vortex dynamics.

We propose here a microwave study of such materials: in fact, currents at very high frequencies induce extremely small oscillations of flux lines. Thus, one probe the single-vortex, small perturbation regime of the vortex matter. Most, if not all, the complications due to the rich physics of the flux lines in cuprates are avoided, and one can concentrate on the intrinsic features: steepness of the potential wells, quasiparticle scattering time and quasiparticle concentration within the vortex cores. By exploiting the simultaneous measurements of real and imaginary part of the response, the genuine flux flow resistivity can be separately extracted from the pinning-related contribution. Thus, the electronic intrinsic anisotropy can be separated from the orientational pinning effects.

The study will compare the transport properties to the microstructure of films grown by physical (Pulsed Laser Deposition) and chemical (metallorganic deposition) techniques.

The work is supported by EURATOM and Italian Ministry of Education.

Techniques in use :

Microwave measurements (power and vector measurements); Cryogenics; Vacuum; Labview © automated data acquisition.

Applicant skills :

Disposition to experimental work, reasonable knowledge of superconductivity

Granted internship : no

C'nano IdF laboratory (France only) : yes / no

Possibility for a thesis : yes , financial support possible after selection according to national rules. Amount of the grant: approximately 13640 €/year (previdential contribution shall be deducted).