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Vortex velocity and vortex lattice configuration in nanostructured magnetic/superconducting hybrids

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Abstract – Electron beam lithography, sputtering and etching techniques have been used to fabricate hybrid magnetic/superconducting systems. These hybrids are magnetic nanodot arrays embedded in superconducting films. In the mixed state vortex lattice dynamics is strongly modified by the magnetic arrays. In this work, we have measured the vortex velocity for soft and hard superconducting materials when the vortex lattice moves on matching and out of matching conditions between the vortex lattice and the array of magnetic dots. We have found that the magnetic arrays govern the vortex velocities, while the background superconducting pinning landscapes play a minor role.

Magnetic/superconducting hybrids are powerful tools to study the competition between two long range order phenomena: magnetism and superconductivity. Many relevant topics could benefit from this interplay. Among them, superconducting mixed state and vortex lattice properties have deserved the attention of many researchers [1]. The pinning landscape, artificially induced by the periodic nanomagnets, governs the vortex dynamics close to superconducting critical temperatures. Hybrids of Ni dot arrays embedded in Nb and amorphous Mo_3Si films have been fabricated by electron beam lithography, sputtering and etching techniques. Once these hybrids have been patterned, magnetotransport measurements allow us studying the vortex dynamics. Close to T_c the array periodic potentials overcome the random intrinsic pinning potentials [2]. In this experimental window, for chosen number of vortices, the vortex lattice is commensurable with the unit cell of the array. Vortex lattice velocity and driving vortex forces could be easily extracted from the experimental data. We have found that for Ni/Nb and for Ni/MoSi hybrids (see Fig 1 and 2) the ordered vortex lattice moves with the same velocities although the background potentials are very different. We will show different results for different vortex lattice configurations and as well as driven forces are able to modify the vortex lattice.

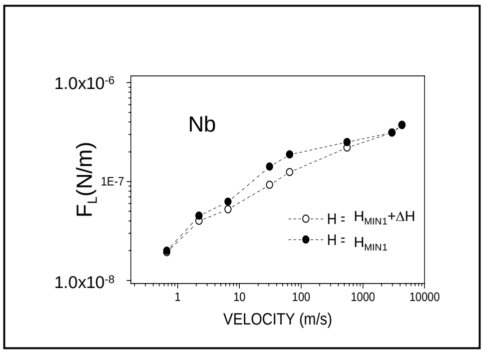

Figure 1: Lorentz force vs. vortex lattice velocity at matching and out-of-matching conditions at T =0.99T_c for Nb films on Ni dots array.

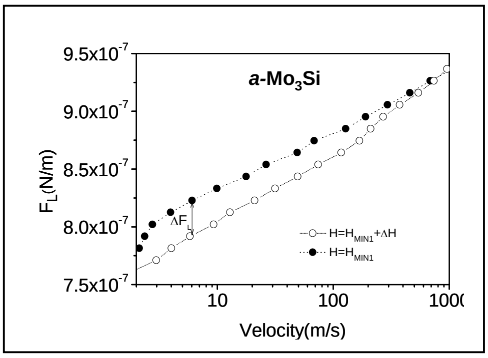

Figure 2: Lorentz force vs. vortex lattice velocity at matching and out-of-matching conditions at T =0.99T_c for *a*-Mo_3Si films on Ni dots array.

References

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