Magnetic Flux Penetration into the Superconducting-Ferromagnetic Bilayer Nb(Co/Pd)

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The vortex dynamics in type II superconductors is a focus of intensive studies because of great scientific and technological interest. It is influenced strongly by the mechanisms of vortex pinning present in the superconductor. One of the mechanisms is the magnetic pinning, in which the ferromagnetic domains or magnetic particles serve as pinning centers. This type of pinning has been examined by many recent experiments. In particular, we have evaluated recently in detail the properties of vortex dynamics in the superconducting-ferromagnetic bilayers in which Nb is a superconductor, and Co/Pt multilayer with perpendicular magnetic anisotropy (PMA) serves as a ferromagnet [1].

In this work we extend our studies to another type of bilayer, built of an Nb layer as a superconductor, and a Co/Pd multilayer as a ferromagnet, and thin Si buffer in-between to eliminate proximity effect. Just like the Co/Pt, the Co/Pd is a multilayer with PAM, but it is characterized by larger domain sizes, as revealed by the magnetic force microscopy imaging. After predefining the domain pattern, we use a line of miniature Hall sensors to image the flux penetration into the Nb layer in the superconducting state. A strong trapping of flux at the sample boundariers is observed, leading to the inhomogeneous flux penetration inside the sample. In addition, we measure the influence of various pre-defined domain patterns on the width of the hysteresis loop in the superconducting state using SQUID magnetometer. These measurements indicate the enhancement of pinning induced by the domains, and the strong dependence of this effect on the domain size. A comparison with the Nb/CoPt system will be made.

[1] Z. Adamus, *Kotwiczenie wirów w heterostrukturach ferromagnetyk/nadprzewodnik*, Praca doktorska, IFPAN, Warszawa 2008; and to be published.