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Vortex pinning in ferromagnet-superconductor bilayer with tunable domain patterns[1]

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Ferromagnet superconductor hybrids provide a fascinating example of systems in which there is a rich interplay between two seemingly incompatible collective phenomena. Particularly interesting is the impact of the ferromagnet on the dynamics of vortices in the superconductor. The magnetic domains control the location of the vortices. Exquisite control of the dynamics can be achieved by careful tuning of the geometry of the magnetic domains. In this talk I will present the results of recent experiments on superconductor(S)-ferromagnet(F) bilayers with a focus on understanding the hitherto unexplained seemingly unpredictable dependence of the critical current density on the parameters of the experiment. In our experiments the S layer is made of niobium, the F layer is a Co/Pt multilayer with perpendicular magnetic anisotropy, and a thin insulating layer in-between eliminates proximity effect. We use various demagnetization procedures to define different domain patterns in the F layer. We show that some domain patterns produce highly inhomogeneous flux penetration and strong vortex confinement at the sample edge, while for others there is remerkable enhancement of the critical current density in excess of 15. This is the highest value reported to date. We have measured, for the first time in a single tunable structure, the dependence of the activation energy for vortex pinning on the domain width, temperature, and magnetic field. In collaboration with L.Y. Zhu, X. M. Cheng and C. L. Chien (Johns Hopkins), Z. Adamus (Polish Acad. Sci.) and M. Konczykowski (Ecole Polytechnique).

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