Enhancement of Critical Current Density in Superconductor – Ferromagnet Multilayers

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Abstract. We have studied the enhancement of a critical current density J_c in superconducting NbN thin film using vortex-matter manipulation. In contrast to the traditional method of vortex pinning at natural or artificially introduced pinning centers, we have performed an alternative method of trapping vortices using two-layer superconductor – ferromagnetic planar structures that are in close proximity. The 50-nm thick NbN film was grown on the c-cut Al_2O_3 substrate by pulsed laser deposition at 600°C in reactive N_2 + 1% H_2 atmosphere and subsequently in situ overgrown with 50 nm thick ferromagnetic layer with various spin polarization – NiCu, Ni and Co. X-ray diffraction analysis of such bilayers showed highly oriented superconducting NbN film, which also exhibited the high superconducting critical temperature Tc, which was not less than 13.5 K in all cases. A three-fold increase in critical current density was observed for the NbN/Co bilayer compared to NbN/NiCu, which directly corresponds to the level of spin-polarization of the ferromagnetic layer.