Magnetoresistance of Si/Nb/Si trilayers

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One of the interesting but still not well understood problems in condensed matter physics is the nature of the superconductor-insulator transition (SIT) in thin (2 dimensional, 2D) superconducting films. The SIT may be induced either by decreasing the film thickness *d* (*d*-SIT), or by application of the external magnetic field *H* (*H*-SIT). Recent studies of some of the 2D systems, InO_x and TiN, in which concentration of carriers (*n*) is small, uncovered unusual properties on the insulating side of the *H*-SIT, including huge magnetoresistance peak [1, 2]. On the other hand, the 2D systems with large *n*, such as MoGe, Bi, PbBi or $Nb_{1-x}Si_x$, display only modest increase of resistance in the vicinity of the *H*-SIT. It has been suggested that unusual effects in the systems with small *n* are caused by the existence of superconducting islands immersed in the insulating matrix [3].

In this work we study the SIT in Si/Nb/Si trilayers, in which the thickness of Si is fixed at 10 nm, and the nominal thickness of Nb changes in the range between *d*=20 nm down to *d*=0,3nm. Our samples are grown by sputtering in the high-vacuum chamber at room temperature. The transmission electron microscopy imaging of the thinnest samples reveals the diffusion of light Si atoms into the Nb layer leading to a formation of well defined mixed NbSi alloy with the thickness of NbSi about 5 times larger than the nominal *d*. The magnetotransport measurements suggest the decrease of *n* with the decreasing *d*. Thus, the trilayers are a promising system in which the evolution from large-*n* to a small-*n* behaviors might be expected with the change of *d*. The details of the evolution of magnetoresistance with the decreasing *d* will be discussed, including the decrease of the critical field, B_c, at which the *H*-SIT occurs, and the scaling properties of the resistance in the vicinity of the B_c. In addition, the current-voltage characteristics for some of the samples will be presented.

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