A huge magnetoresistive effect in n-Si/SiO_2/Ni nanostructures fabricated by the template-assisted electrochemical deposition

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In this work we study the carrier transport and magnetotransport properties in the bundles of Ni nanorods embedded into the n-Si/SiO_2 porous template created by selective etching of swift heavy ion tracks in a SiO_2 layer when the pores are filled with nickel nanoparticles. The study of the carrier transport and magnetotransport in such nanostructures was performed over the temperature range 2 – 300 K and at the magnetic field induction up to 8 T.

As our study have shown, the n-Si/SiO_2/Ni nanostructures, being electrically similar to two Si/Ni Schottky diodes switched-on opposite to each other, display 3 contributions to the temperature dependences of equilibrium DC resistance: the zone-like carrier transport by Si substrate (at $T > 250$ K); impurity conductance by the phosphorus-doped Si substrate (at $15\ \text{K} < T < 180\ \text{K}$) when the zone-zone carrier transport by Si wafer is freezed-out; and hopping conductance by the localized states at $T < 15$ K when electrons become to move along the n-Si/SiO_2 interface over the electrons-enriched layer due to the band bending.

In n-Si/SiO_2/Ni nanostructures at the temperatures ranging 17 – 27 K, where impurity conductance by the phosphorus-doped Si substrate is predominant, a considerable positive contribution to the MR effect is observed, that may be attributed to two possible reasons - the influence of Si/Ni Schottky barriers and/or movement of electrons along the electrons-enriched Si/SiO_2 interfacial channel.