Role of Spin-Orbit Scattering in Nanostructured S/F Point Contacts

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We report on spin-dependent transport through nanosized Al/Fe point contacts. The contacts are prepared by electron-beam lithography in a silicon-nitride membrane and subsequent evaporation of the metal films on either side of the membrane [1,2]. The main advantage of this technique is the high stability of the nanostructured contacts which allows detailed investigations of the temperature and magnetic-field dependence of the current-voltage characteristics. By variation of the process parameters contacts with contact resistance R between $R < 1\ \Omega$ and almost $30\ \Omega$ are obtained. Andreev reflection of charge carriers at the interface between superconducting Al and ferromagnetic Fe is used as a tool to determine the spin polarization P of the transport current. The dI/dV vs. V spectra are measured in a dilution refrigerator at $T < 1$ K and analysed in the framework of a model describing the transport through an S/F point contact with two spin-dependent transmission coefficients $\tau_{\uparrow,\downarrow}$ [3]. Only spectra measured at $T < 200$ mK $<< T_c^{Al}$ are considered for the analysis. The current spin polarization defined by $P = |\tau_{\uparrow} - \tau_{\downarrow}|/(\tau_{\uparrow} + \tau_{\downarrow})$ is explored by varying the contact resistance R by about one order of magnitude. P is enhanced for high-ohmic contacts when the contact approaches the ballistic transport regime and scattering in the contact region is reduced. Assuming spin-orbit scattering as the main source of the reduction of P, with $P(a) \sim exp(-a/l_{so})$ where the contact radius a is deduced from the contact resistance R via the Wexler formula [4], a spin-orbit scattering length $l_{so} \approx 280$ nm is obtained.

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