Spin-polarized transport in ferromagnetic semiconductor / diffusive semiconductor / superconductor junctions

(Hideaki Takayanagi)

Abstract :

We will report on transport properties in a p-$In_{0.94}Mn_{0.06}As$/n-InAs/Nb junction which contains both a ferromagnet/semiconductor (p-$In_{0.94}Mn_{0.06}As$/n-InAs) interface and a superconductor/semiconductor (Nb/n-InAs) one. When spin-polarized holes from p-$In_{0.94}Mn_{0.06}As$ are diffusively injected into the nonmagnetic n-InAs channel, electrons in the n-InAs channel should be spin-polarized. On the other hand, the Andreev reflection at the Nb/n-InAs interface affects the local conductivity at a point in the n-InAs channel far from the interface. Therefore, novel phenomena of electric transport in the p-$In_{0.94}Mn_{0.06}As$/n-InAs/Nb junction can be expected from the interplay between spin polarization and Andreev reflection.

We measured the voltage V dependence of the differential conductance of the n-InAs channel between two Ti/Au electrodes and obtained conductance minima within $|V| \leq 2$ mV. With increasing current injection from p-$In_{0.94}Mn_{0.06}As$, the conductance minima gradually disappeared. On the other hand, in case of current injection from the Nb electrode, the conductance minima split and then shifted toward high bias with increasing injection current. The difference between these dependences on injection current suggests that transport in the n-InAs channel is affected by the competing mechanisms of spin polarization in the n-InAs channel and Andreev reflection at Nb/n-InAs interface.

We also did a self-consistent calculation for the conductance of the junction with taking into account of the exchange filed that penetrates into the superconductor. The calculated results can explain the conductance behavior as a function of spin-polarized injection current and non-polarized one.