H-shaped Cd(Mn)Te Nanostructure For the Observation of Inverse Spin Hall Effect (ISHE)

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The incorporation of magnetic ions into semiconductor causes strong modification of the host material parameters. Such a class of materials, called diluted magnetic semiconductors (DMS), shows the unique features e.g. large Landé g-factor. Cd(Mn)Te based structures combine properties of DMS with the presence of the high mobility two-dimensional elctron gas (2DEG). Therefore, Cd(Mn)Te nanostructures are the material of choice for spin current generation and have been investigated in the magnetic field gradient[1] and in T-shaped device[2]. Furthermore, relatively strong spin-orbit interaction gives possibility of spin current detection via ISHE using H-shape devises[3]. In the presented work we focus on modulation doped CdMnTe/CdTe quantum wells defined by the electron beam litography into submicron four-terminal H-shape. The structure is placed in the vicinity of permalloy film. That configuration provides the gradient of magnetic film to the system. 2DEG transmission, wave functions distribution and current density are calculated numerically using the tight-binding approximation with the Kwant code[4]. Rounded corners, finite edge potential and spin-orbit interaction are taken into consideration to ensure real condition of the experiment in the numerical model. Results of simulation are compared with experiment performed at temperature below 1 K and in the magnetic field up to 6 T.

We propose H-shaped DMS devise for both generation and detection of spin currents. Simulation using Kwant, device fabrication and transport properties of prototypical device have been performed. The research was partially supported by the National Science Centre (Poland) through Grant No. DEC- 2012/06/A/ST3/00247 and by the Foundation for Polish Science through the IRA Programme co-financed by EU within SG OP.

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