Spin diffusion across hugely lattice mismatched heterointerfaces

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An ability to control the electron spin rather than its charge represents the basic requirement of an emerging field of spintronics. A major progress has been made recently by demonstrating an effective spin injection across a semiconductor interface without substantial loss of its quantum coherence. Yet another important progress was made by incorporating magnetic semiconductors as spin aligners with spin injection has been achieved either optically [1] or electrically [2] across diluted-magnetic/normal semiconductor. In all cases, an extreme care was taken to assure a good lattice matching of the constituent layers of the entire structure. A natural question arises concerning the role of lattice matching as a factor limiting the effectiveness of the spin transport across different semiconductor interfaces.

In this work we study a very large (~8%) lattice-mismatched materials where the hetero-interface includes a large amount of misfit dislocations as evidenced in TEM images. Our structure consists of 1.1μm thick $Zn_{0.97}Mn_{0.03}Te$ layer, playing the role of the spin aligner, grown on top of $Ga_{0.8}In_{0.2}As$/GaAs quantum well burried 200Å below the heterointerface. The later structure serves as a spin polarization detector. The growth process has been carried out in separated steps using two different MBE machines. Nevertheless, the high-resolution TEM images show a good crystalline character of the interface itself with an array of dislocations being present in the spin aligner. Magneto luminescence experiments have been carried out in a magnetic field range from 0-5T at 1.8K. Circular polarized excitation (σ^+ and σ^-) above and below the ZnMnTe band gap was used in the Faraday geometry. The degree of the circular polarization (ρ) detected of the GaInAs QW luminescence was measured.

PL measurements exhibit in the case of the excitation above the ZnMnTe band gap at 4T ρ ~20% under σ^+ circularly polarized light while a lower value ρ ~ 2%, under σ^- excitation. Moreover, the degree of the circular polarization has been measured as a function of the magnetic field for the both circular polarization excitations and for various excitation energies. The effect is absent in the below the ZnMnTe band gap excitation. A significant difference in ρ in the former case is then observed, which can be interpreted as being due to electrons with spin down orientation diffusing from the diluted magnetic layer ($g^* > 0$) to the non-magnetic ($g^* < 0$) QW although a dense array of misfit dislocations is present at the heterointerface.

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