SPIN INJECTION, MANIPULATION AND DETECTION IN SILICON

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Spin injection, manipulation and detection are concepts at the heart of spintronics. Recent experiments have shown that these concepts are realizable in silicon. The great importance of these findings stems from the wide use of silicon in semiconductor technology. Three types of experiments have contributed to the breakthrough: (i) hot injection with electrical detection [1], (ii) injection through an oxide barrier with optical detection [2], and (iii) non-local detection [3]. In case (i) a four-probe device was used; spin coherence was shown to persist at more than 350µm; spin manipulation was demonstrated through the Hanle effect (spin precession in a magnetic field). In case (ii), smaller spin coherence lengths were demonstrated (at least as much as 80nm), with the advantage, however, of a higher current density. Case (iii) is a complementary proof of spin injection in silicon, based on a Johnson-Silsbee type of experiment for non-local spin detection in a lateral device. Depending on temperature and experimental setup, the current polarization in these experiments can exceed 30%. Finally, the case of injection from Fe(001) into Si through the Si Schottky barrier has been examined via ab-initio calculations [4]. It is found that the six-fold degeneracy of the Si conduction band edge, together with the complex band structure in the barrier, can allow for a tunable control of the current polarization. In limiting cases, that are, however, difficult to realize in practice, the calculated polarization almost reaches the ideal 100%, due to a symmetry mismatch of wave functions at the interface.

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