Spin behaviour in strained silicon films

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Resume : Growing technological challenges and soaring manufacturing costs are gradually bringing MOSFET scaling to an end. This ignites the search for alternative technologies and computational principles. The electron spin is a plausible candidate for complementing or even replacing the electron charge in future electron devices. Silicon is an ideal material for spin electronic (spintronic) applications due to the long spin lifetime. The spin relaxation is determined by spin-flip scattering between the valleys located on different crystallographic axes. Although this mechanism is suppressed in thin films and inversion layers, a stronger spin relaxation in gated silicon structures was observed. Understanding the spin relaxation mechanisms and identifying ways to boost the spin lifetime in confined electron systems is urgently needed for future spin-based devices. We investigate spin relaxation in (001) silicon structures by taking into account the surface roughness and electron-phonon mediated spin scattering. To find the wave functions, matrix elements, and scattering rates we use an effective k•p Hamiltonian for the two relevant valleys with shear strain and spin included. We show that the spin relaxation is suppressed in strained films. The spin lifetime is enhanced much stronger than the momentum relaxation time. Tensile shear strain routinely used to boost the electron mobility is even more efficient in boosting the spin lifetime in silicon films.

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