Experimental determination of the spin relaxation mechanism in highly-doped n-type germanium epilayers.

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Group IV semiconductors spintronics attracts immense attention in the spintronics community due to compatibility with modern electronics and long spin diffusion length. Silicon (Si) and germanium (Ge) possess the crystal inversion symmetry, which suppresses of the Dyakonov-Perel spin relaxation mechanism, leading to a long spin relaxation time. Carrier mobility of Ge is almost order of magnitude higher than in Si, making Ge very attractive for technological applications. However, in contrast to success of room-temperature Si spintronics, observation of spin transport in Ge in non-local geometry was restricted to low temperatures until recently [1]. Using spin pumping under ferromagnetic resonance for spin injection and inverse spin-Hall effect for spin detection, we achieved room-temperature spin transport in n-Ge epilayers and report a temperature dependence of a spin relaxation time in n-type Ge epilayers [2]. Previously Elliott-Yafet spin relaxation mechanism was reported to be dominant at $T < 100$ K in n-Ge [3]. In our study we cover important temperature range from 130 K to 297 K and show that spin relaxation time slowly increasing with decreasing temperature. We demonstrate that spin relaxation mechanism in doped n-Ge is not governed by either intravalley or intervalley phonon scattering, but originates from the intervalley donor-driven spin relaxation. Our result is in agreement with the recently proposed theory of impurity scattering spin relaxation in in multivalley semiconductors, which is governed by an intervalley short range scattering off the central-cell potential of impurities [4].

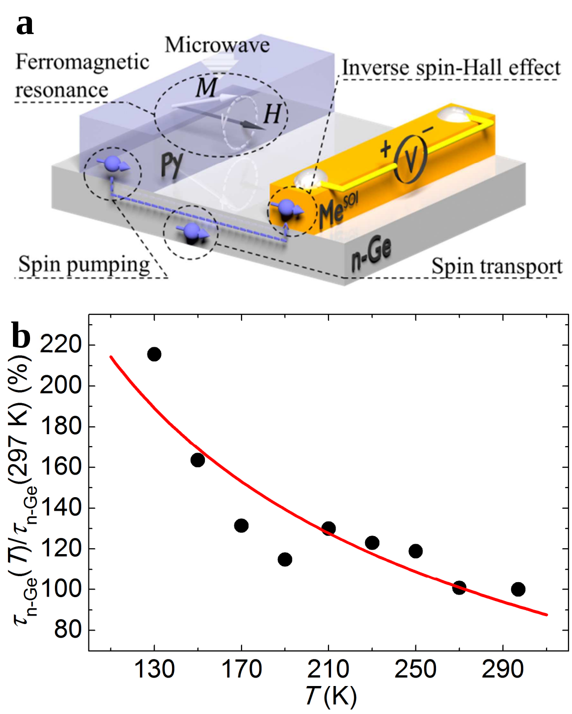

Fig. 1. Determination of the spin relaxation mechanism in n-type Ge epilayers. **a**, Layout of the experimental setup. **b**, Normalized temperature dependence of the spin relaxation time [2].

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