Room-temperature spin diffusion length in strained SiGe

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Recent studies revealed that spin diffusion length (λ_s) and spin lifetime (τ_s) of electrons in Ge at room temperature are governed by phonon-induced spin-flip scattering between conduction band valleys (intervalley spin-flip scattering) [1]. So far, although we have shown the suppression of impurity-induced intervalley scattering in a strained $Si_{0.1}Ge_{0.9}$ having a Ge-like band structure at low temperatures [2], the effect of the strain on room-temperature λ_s and τ_s has not been verified in Si_xGe_{1-x} ($0 \leqq x \leqq 0.4$).

A strained *n*-$Si_{0.1}Ge_{0.9}$ spin transport layer (~70 nm) with a carrier concentration of ~1.0×10^{18} cm^{-3} and an electron mobility of ~823 cm^2/Vs was grown on Ge/Si(111) substrates by molecular beam epitaxy (MBE). Then, we fabricated lateral spin-valve (LSV) devices with Co_2MnSi/Fe spin injection/detection contacts, as shown in Fig.1 (a), for spin transport measurements. A representative four-terminal nonlocal spin signal ($|\Delta R_{NL}|$) at room temperature is shown in Fig.1 (b) for an LSV with d = 0.4 μm, where d is edge-to-edge distance between Co_2MnSi/Fe contacts. Figure 1 (c) shows d-dependent $|\Delta R_{NL}|$ at room temperature for LSV devices with the strained *n*-$Si_{0.1}Ge_{0.9}$ and an *n*-Ge. From the standard theory, the value of λ_s for the strained *n*-$Si_{0.1}Ge_{0.9}$ is estimated to be ~0.93 μm, longer than λ_s (~0.76 μm) for *n*-Ge. We attribute the enhancement in λ_s to the enhancement in the electron mobility and/or the suppression of intervalley spin-flip scattering by the strain-induced lifting of valley degeneracy.

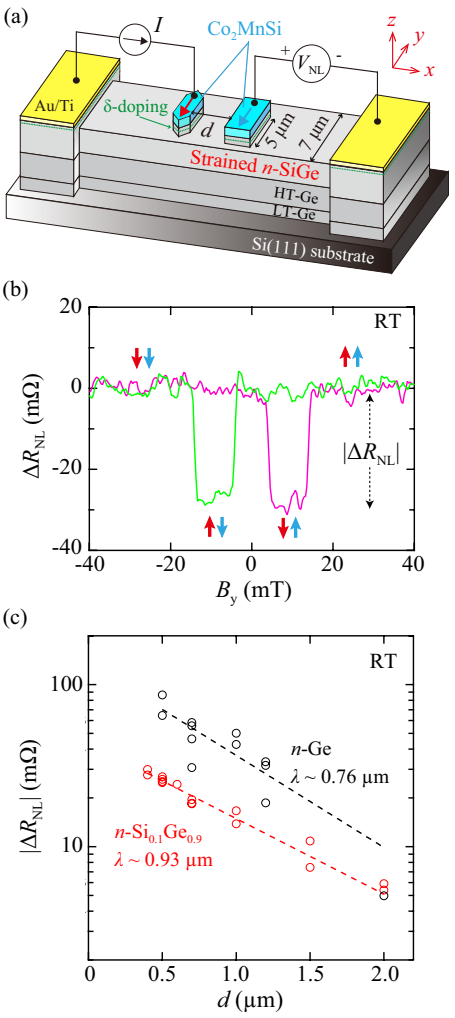

Fig. 1(a) Schematic of an LSV device with a strained *n*-SiGe. (b) A four-terminal nonlocal spin signal measured at room temperature for an LSV with d = 0.4 μm. (c) d-dependence of $|\Delta R_{NL}|$ for LSV devices with the strained *n*-$Si_{0.1}Ge_{0.9}$ and an *n*-Ge at room temperature.

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