Spin-dependent transport properties of a GaMnAs-based vertical spin metal-oxide-semiconductor field-effect transistor structure

TOSHIKI KANAKI, HIROKATSU ASAHARA, SHINOBU OHYA, MASAAKI TANAKA, The University of Tokyo — Spin metal-oxide semiconductor field-effect transistors (spin MOSFETs) [1] are one of the most promising devices for the post-scaling era. In previous studies on spin MOSFETs [2,3], the drain-source current was controlled by the gate-source voltage and magnetization configuration of the source and drain; however, the magnetoresistance (MR) ratios (0.1% [2] and 0.005% [3]) were too small to be put into practical applications, and thus spin MOSFET with a high MR ratio is strongly required. Here, we study a GaMnAs-based vertical spin-MOSFET structure. We successfully modulate the drain-source current $I_{DS}$ by $\sim0.5$ (–0.5) % with a gate-source voltage of −10.8 (+10.8) V and also modulate $I_{DS}$ by up to 60 % with changing the magnetization configuration of the GaMnAs source/drain at 3.5 K. The MR ratio is more than two orders of magnitude higher than that obtained in the previous studies on spin MOSFETs [2,3][4].


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