Current-driven channel switching and colossal positive magnetoresistance in the manganite-based structure

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Abstract: The transport and magnetotransport properties of a newly fabricated tunnel structure manganite/depletion layer/manganese silicide have been studied in the current-in-plane (CIP) geometry. A manganite depletion layer in the structure forms a potential barrier sandwiched between two conducting layers, one of manganite and the other of manganese silicide. The voltage-current characteristics of the structure are nonlinear due to switching conducting channels from an upper manganite film to a bottom, more conductive MnSi layer with an increase in the current applied to the structure. Bias current assists tunnelling of a carrier across the depletion layer; thus, a low-resistance contact between the current-carrying electrodes and the bottom layer is established. Below 30 K, both conducting layers are in the ferromagnetic state (magnetic tunnel junction), which allows control of the resistance of the tunnel junction and, consequently, switching of the conducting channels by the magnetic field. This provides a fundamentally new mechanism of magnetoresistance (MR) implementation in the magnetic layered structure with CIP geometry. MR of the structure under study depends on the bias current and can reach values greater than 400% in a magnetic field lower than 1 kOe. A positive MR value is related to peculiarities of the spin-polarized electronic structures of manganites and manganese silicides.
Index Keywords: Colossal magnetoresistance; Electric resistance; Electronic structure; Magnetic field effects; Magnetoelectronics; Manganese; Manganites; Oxide minerals; Schottky barrier diodes; Semiconductor junctions; Silicides; Tunnel junctions; Tunnels; Bottom layers; Channel switching; Conducting channels; Conducting layers; Current-driven; Current-in-plane geometries; Depletion layers; Ferromagnetic state; Layered structures; Low-resistance contacts; Magnetic tunnel junctions; Magneto-transport properties; Manganese silicides; Manganite films; New mechanisms; Positive magnetoresistances; Positive MR; Potential barriers; Spin-polarized; Tunnel structures; Voltage-current characteristics; Current voltage characteristics

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