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Resistive change depending on state of the two Co nanomagnets by the magnetic and the electric field

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Spin-controllable electronic devices have received considerable interest because of non-volatile property. Special interest are recently focusing on current-induced magnetization switching (CIMS) device, where a spin-polarized current will affect the magnetic state of a ferromagnetically ordered(FM) conductor via the transfer of angular momentum between the carrier spin and the conductor's magnetic moment. We have prepared two kinds of Co thin film nanomagnets with multi-domain and single-domain in the structure of IrMn (8 nm)/Co (11 nm)/Cu (2 nm)/Co (2 nm)/Cu (2 nm)/Au (5 nm)/Cu (100 nm) and have studied the resistance change by the magnetic field and electric current. CPP-magnetoresistance shows a square shaping stepped hump with increasing and decreasing field, because of the switching between anti-parallel state (high-resistance) and parallel (low-resistance) state of the two Co nanomagnets. By applying current, the resistance is changed into anti-parallel state at positive critical current, I(AP->P) and switched back to parallel state at negative critical current, I(P->AP), which is ascribed to the spin-angular-momentum transfer from spin-polarized incoming electrons to local magnetizations. Interestingly enough, the average switching current density is estimated to be 6 X 107 A/cm2 for regardless of the domain structure. Moreover, we have studied the switching time by measuring the resistance after pulse current. The switching time for multi-domain CIMS device appears to be much longer than the single-domain one. These results indicate that the domain structure is a crucial role in the switching time, not the switching current of CIMS devices.