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Energy-efficient optoelectronic domain-wall motion for logic computing

Magnetic logic has the advantage of non-volatility and scalability and can execute different logic gate operations. The dynamics of domain-wall (DW) motion has become a research focus for its potential applications in high density magnetic memory and logic devices, where data are stored non-volatilely in the form of magnetic domains separated by DWs along magnetic wires. Magnetic DW logic gates were first realized using a rotating-field-induced DW motion in sub-micro magnetic wires, including NOT, AND, fan-out and cross-over elements. As the external magnetic field limited their implementation, all-current chiral DW motion based on spin-orbit torque (SOT) was exploited for magnetic logic. However, the power consumption for DW logic operation is still relatively high. Recently, logic structures based on laser pulses have been proposed. All-optical switching (AOS) has the advantages of faster writing speed and lower power consumption, which can be an alternative approach for the realization of advanced magnetic logic devices. We demonstrate DW logic computing combining all-optical helicity-dependent switching (AO-HDS) and current-induced SOT switching. Four logic functions are realized. Our findings provide additional insights toward energy-efficient optical-spintronic logic computing.

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