IA-16

Integrated magnetoelectric devices based on interfacial magnetoelectric coupling effects

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Magnetic properties such as magnetic anisotropy, ferromagnetic resonance, and exchange bias, have been electrically manipulated via magnetoelectric coupling effects, which enable promising applications in electrically tunable magnetic devices. However, these electric field control processes are usually confined at large scale in bulk materials, and the integration of these magnetoelectric materials with semiconductor process in practical devices is still challenging. The interfacial magnetoelectric coupling effects have been reported in thin film heterostructures, which are compatible with the micro-electro-mechanical systems (MEMS) processes. In this work, we design several integrated magnetoelectric devices including tunable magnetic sensors and microwave signal processors, based on the interfacial magnetoelectric coupling effects. High sensitivity and large tunability can be realized with a circuit operation voltage. More importantly, these magnetoelectric devices can be integrated onto flexible substrates for wearable electronics. Our work paves the way toward ultrafast, compact, and power efficient spintronic/electronic devices based on interfacial magnetoelectric coupling.