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Bi-directional Two Terminal Switching Device based on SiGe for Spin Transfer Torque (STT) MRAM

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A two terminal N+/P/N+ junction device to replace the conventional selective transistor was studied as a bilateral switching device for spin transfer torque (STT) MRAM based on 3D device simulation. An N+/P/N+ junction structure with 30 × 30 nm area requires bi-directional current flow enough to write a data by a drain induced barrier lowering (DIBL) under a reverse bias at N+/P (or P/N+ junction), and high current on/off ratio of 106. The SiGe materials are widely used in hetero-junction bipolar transistors, bipolar compensation metal-oxide semiconductors (BiCMOS) since the band gap of SiGe materials can be controlled by changing the fraction and the strain epilayers, and the drift mobility is increased with the increasing Ge content. In this work, N+/P/N+ SiGe material based junction provides that drive current is increased from 40 to 130 μA by increased Ge content from 10~80%. When Ge content is about 20%, the drive current density of SiGe device substantially increased to 2~3 times better than Si-based junction device in case of 28 nm P length, which is sufficient current to operation of STT-MRAM.

Keywords: Bilateral switching device, SiGe