Geometry Dependence of the Switching Time in MTJs with a Composite Free Layer

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Magnetoresistive random access memory with spin transfer torque (STT-MRAM) is a promising candidate for future universal memory. Perpendicular MTJs with an interface-induced anisotropy show potential, but still require damping reduction and thermal stability increase. Thus, finding alternative architectures for MTJ structures is of considerable importance for the success of STT-MRAM. Previously a MTJ with a composite free layer (C-MTJ) was proposed. The free magnetic layer of such a structure consists of two equal parts of half-elliptic form separated by a non-magnetic spacer. C-MTJs demonstrate a substantial decrease of the switching time and switching current.

We have investigated the switching statistics dependence on the geometry of the composite layer. We find that in C-MTJs with an elongated short axis the width of the switching time distribution is almost ~2000 times narrower than that in MTJs with a monolithic free layer. To find an explanation for this distribution narrowing, we analyze the switching process in detail. Each half of the free layer generates a stray magnetic field which influences the dynamics of the other half. This stray field increases with increasing short axis, which leads to the switching times distribution narrowing. Therefore, the investigated C-MTJ offers great potential for performance optimization of STT-MRAM devices.

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