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TUNNEL MAGNETORESISTANCE IN HETEROGENEOUS PLANAR SINGLE-BARRIER MAGNETIC TUNNEL JUNCTIONS

Petukhov D.A., Useinov N.Kh.
Kazan Federal University, Kazan, Russia
dapetukhov@mail.ru

Currently, layered magnetic nanostructures FM/I (ferromagnet/insulator) is one of the most exciting and rapidly developing areas of spintronics. Effects of tunneling magnetoresistance and magnetization switching in such structures are used in magnetic field sensors, nonvolatile magnetoresistive memory (MRAM, ST-MRAM), resonant tunneling diodes, spin transistors [1, 2]. In this report, we investigate theoretically the heterogeneous single-barrier magnetic nanostructures $FM^L/I/FM^R$. They consist of two ferromagnetic layers separated by dielectric layer. As the ferromagnetic layers material, Fe, Co, Ni and their alloys (CoFeB, FeNi) are considered. Insulating layers are usually AlO_x or MgO. Magnetization of one of the outer sheets (FM^L, FM^R) are pinned by the exchange bias effect. Magnetization of the other layer can be changed by an external magnetic field.

Here we report on results of investigation of the spin-dependent transport and tunnel magnetoresistance in heterogeneous (asymmetric, $FM^L \neq FM^R$) single-barrier magnetic tunnel junctions. We use free electron model and two parabolic subbands approximation for the conduction band of ferromagnetic layers. Our model of the junction takes into account different effective electron masses in the ferromagnetic metals conduction subbands and the barrier as well, arbitrary widths of the spin-subbands and the barrier heights at the FM-I interface. In every FM layer, we set the orientation of the magnetization with two spherical angles θ, φ. Spin of the electron is conserved during tunneling trough the junction.

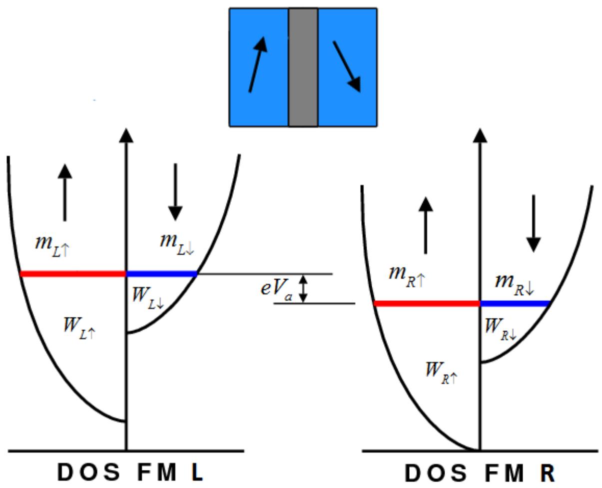

Fig. 1. Schematical view of heterogoneous single-barrier magnetic tunnel junciton.

Analysis of the electron tunneling is based on the model of spin-conduction channels. Current calculation is performed using the quasiclassical theory. The ferromagnetic layers are discussed in the framework of two-band model. Transmission coefficients of the structure are calculated quantum-mechanically in the effective-mass approximation for the conduction electrons. The present model is a modification of the model described in [3] for the case of arbitrary directions of layers magnetizations.

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[2] S. Ikeda *et al.*, *IEEE Trans. Electron Devices*, **54** (2007) 991–1002.
[3] D.A. Petukhov, *Physica E*, **80** (2016) 31-35.