Features of Electrically Induced Spin Torque Effect in Multilayer Magnetic Nanostructures

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The exchange interaction between the spin polarized states of conductivity electrons and localized spin states in multilayer magnetic nanostructures underlies the effects of electric field-controlled change of localized magnetic states and the spin dependent electron scattering which depends on the configuration of the localized magnetic states. The efficiency of the first effect characterizes by the threshold spin current density which is sufficient to overcome the magnetic anisotropy forces. In this context, the most favorable is the generation of spin current and spin polarization through the spin-orbit interaction when, in contrast to the generation through an effective magnetic field of an magnetic polarizer, the spin current is not accompanied by charge transfer and power consumption. These effects are related to the effect of so-called spin torque exerting on the vector of magnetic order corresponding to both ferromagnetic and antiferromagnetic exchange interaction [1].
For the ferromagnetic multilayer nanostructures, the mentioned two effects are associated with electric controlled magnetization dynamics and switching and also the magnetoresistance effect that are related to processes of magnetic writing and reading information. In the antiferromagnetic case (possessing zero magnetization) the mentioned spin interaction results in the controlled dynamics of antiferromagnetic order vector that is currently a completely unsolved problem. Due to the strong antiferromagnetic exchange interaction and, accordingly, the high frequency of remagnetization, it is important modeling and description of both ferromagnetic and antiferromagnetic dynamics [2].
The microscopic description of the electric-controlled dynamics in the tunnel multilayer ferromagnetic nanostructures is based on the modified for magnetic system theory of non-equilibrium Green functions with the real-time propagation of the embedded Kadanof-Baym equations which are quantum-kinetic equations for the one-particle propagator. It is shown, that these equation in the tight-binding representation systematically describe features of the spin current-induced spin torque effect accompanied by the remagnetization and the inverse effect of the influence of the magnetic configuration on the conductivity of the magnetic nanostructures.

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References:
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