Numerical investigation of the magnetization dynamics of a perpendicular polarizer-perpendicular free layer spin transfer torque nano-oscillator.

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We numerically investigated the conditions of field and current for inducing steady state excitations in a magnetic stack based on a fully perpendicular magnetic tunnel junction. The simulations were carried out by solving the Landau-Lifshitz-Gilbert equation [1] in the macrospin approach for a simplified configuration, for which the polarizer orientation is fixed (out of plane) and only the free layer magnetization can move under the action of the applied magnetic field and the spin-polarized current. We also considered the contribution of an additional second order uniaxial anisotropy term, which has been recently observed in perpendicular MgO-based magnetic tunnel junctions [2], and both damping-like and field-like spin transfer torque terms. Using this model we evaluated the type, shape and spread of static and dynamic states zones of the free layer magnetization on a voltage-field diagram of states as a function of different material and simulation parameters such as the first and second order uniaxial anisotropy, the damping-like and field-like spin torque terms, the sample geometry and thickness, the applied field strength and orientation, and the temperature. We also estimated the amplitude and the frequency dispersion of the steady state oscillations, the type and shape of the free layer magnetization trajectories and compare some of our results with experimental measurements.

[1] L. D. Landau and E. M. Lifshitz, Phys. Z. Sowjet. 8, 153 (1935).

[2] A. A. Timopheev, et al., Scientic Reports 6, 26877 (2016).

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