Microwave emission from spin torque oscillators based on asymmetric magnetic tunnel junctions

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DC currents in magnetic tunnel junctions (MTJ) can induce steady state precessions when the current density is sufficiently high, due to the interaction between spin-polarized electrons and the local magnetization of the free layer (FL). This spin-transfer-torque (STT) effect induces resistance fluctuations in the MTJ which in turn generate an AC signal in the microwave frequency range[1]. Here, we report on STT in asymmetric MTJs with a $Co_{40}Fe_{40}B_{20}$(2.3)/MgO(0.9)/ $Co_{40}Fe_{40}B_{20}$ (1.2-1.6) (thickness in nm) structure. The magnetization of the thin CoFeB FL is tilted out of the film plane due to perpendicular interface anisotropy[2]. The MTJs, which are patterned into ellipses and circles with an area 0.028 μm^2, exhibit a resistance area (RA) product of 3 Ohmμm^2 and a tunneling magnetoresistance ratio of up to 100%. Contrary to symmetric CoFeB-based MTJs, in asymmetric MTJs, asymmetric dI/dV vs. voltage curves are observed[3]. Ferromagnetic coupling between the reference layer (RL) and FL stabilizes the low resistance state of the MTJs at zero applied magnetic field[4]. For DC currents that favor the high resistance antiparallel magnetization state, RF oscillations are observed even without the application of an external magnetic field. An increase of the DC current results in decreasing the oscillation's frequency (redshift). The amplitude of the oscillation exceeds 10 nV/$Hz^{1/2}$ at 1.5 GHz and 1.7 mA observed[5]. Detailed study of current driven microwave oscillators based on asymmetric MTJs will be presented.

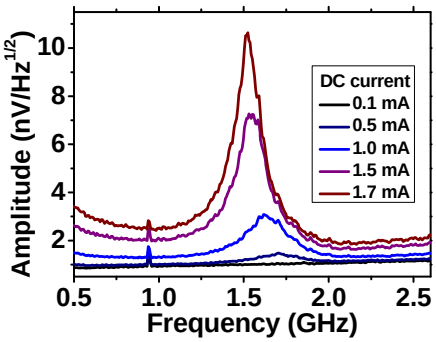

Figure: Microwave signal of the MTJ measured at low resistance state and current between 0.1 and 1.7 mA with no external magnetic field applied.

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