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Temporal Coherence of MgO Based Magnetic Tunnel Junction Spin Torque Oscillators[1]

URSULA EBELS, SPINTEC CEA/CNRS/UJF

In magneto-resistive (MR) devices, spin momentum transfer can be used to induce large angle steady state magnetization oscillations that are converted into an AC output voltage. This oscillating output signal has been in most cases investigated in the frequency domain using a spectrum analyser. However, in the case of tunnel junction devices, it is often difficult to clearly distinguish the steady state excitations from thermally excited spin wave modes. In this presentation we investigate the oscillator output signal in the time domain using single shot time domain analysis for MgO based magnetic tunnel junction oscillators with RA values of 1 and 1.5 Ohmmicron2 and TMR values of 30 - 90 % [1]. Single shot time domain studies provide important additional information [2], since they do not average over several signal traces and thus reveal the true transient character of the oscillations. Here we address several issues: (i) the definition of the critical current for a stationary steady state, (ii) 'simultaneous' presence of two modes, (iii) the coherence time deduced from the correlation function of the signal, amplitude and phase, (iv) identification of frequency fluctuations and (iv) estimation of the intrinsic linewidth, upon suppressing 'numerically' frequency fluctuations [3]. This is illustrated for two types of tunnel junction oscillators that differ in their magneto-resistance value and in their dynamic behaviour. The experimental results will be supported by numerical simulations that take various noise contributions into account.

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[2] I. N. Krivorotov et al., Science **307**, 228 (2005); I. N. Krivorotov, et al., Phys. Rev. B **77**, 054440 (2008).
[3] D. Houssameddine et al., Phys. Rev. Lett. **102**, 257202 (2009)

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