SINGLE PEAKED SPIN TORQUE RF MODE IN A LOW RESISTANCE AREA NANOPILLAR DEVICE

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The enormous amount of experimental research on spin transfer torque in recent years has shown that a spin polarized current can induce an oscillatory motion of the magnetization, yielding GHz frequency oscillations. These oscillations, which turn out to be field and current tunable, are very promising for future wireless communication devices. One of the bottlenecks for integration is the lack of oscillatory power provided by these spin torque oscillators. As solutions to overcome this power problem the increase of the resistance and magnetoresistance of the oscillators has been suggested. Hence the use of MgO based tunnel junctions, as in this report, is a very promising route towards increasing output power. Compared to spin valve multilayers (with typical MR ratios of 10%) MgO based tunnel junctions yield MR ratios up to 500% at room temperature for a CoFeB/MgO system [1]. It was also shown that tunnel junctions can show spin torque oscillations [2, 3] even under high bias voltages which shows the potential of MgO for oscillator applications if higher powers can be reached.

Here we describe RF-oscillations in a nanopillar that was fabricated from the following magnetic tunnel junction (thickness in nm): Ta 3/CuN 40/Ta 5/PtMn 20/$Co_{70}Fe_{30}$ 2/Ru 0.8/$Co_{60}Fe_{20}B_{20}$ 2/MgO 0.9/$Co_{60}Fe_{20}B_{20}$ 3/Ta 4. The stack was characterized through the creation of micrometer sized junctions which resulted in an RA (Resistance Area) product of 1 to 3 $\Omega.\mu m^2$ and TMR values ranging from 10% to 70%. The rectangular nanopillars of 70x140 nm^2 are created by means of e-beam lithography and ion beam etching. The resistances of the two remanent states are 136 and 154 Ω resulting in a TMR of 13% and an RA product of 1.4 $\Omega\cdot\mu m^2$.

The junctions can be spin torque induced switched very reproducibly between the parallel and antiparallel magnetization state by currents of -1.5 and 1.7 mA. The RF spectra of these nanopillars were analyzed for applied currents between -8 and 8 mA with easy and hard axis fields from -150 to 150 mT. Free layer spin torque induced excitations are expected in the quadrants $H>0$, $I<0$, where the field favors parallel alignment and the current favors anti-parallel alignment of the magnetizations, and $H<0$, $I>0$, but they were not observed. Conversely, excitations in the 9 to 10 GHz range, with clear threshold current (characteristic for spin torque induced oscillations) of -6.4mA, were observed in the $H<0$, $I<0$ quadrant, when the samples was prepared in the P state prior to experiment. This mode is thought to be an excitation of the SAF system. Linewidths down to 54 MHz and narrow band emitted power up to 0.04nW were observed.

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