

Investigation of the emission power and Q factor of the MgO-based spin-torque oscillators with different diameters

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Spin-torque oscillators (STOs) with a narrow linewidth and large emission power have been proposed as a new type of microwave generators and highly sensitive magnetic field sensors, based on the theoretical predictions and experimental observations of spin transfer torque. MgO-based magnetic tunnel junctions (MgO-MTJs) which exhibit large tunnel magneto-resistance ratio are beneficial for enhancing the emission power [1-3]. In this research, nanopillar STOs with different diameters were fabricated and the emission power and Q factor were studied.

Figure 1 shows the structure of STO film. The CoFeB reference layer is coupled to the CoFe pinned layer to form a synthetic antiferromagnet. The FeB free layer is perpendicularly magnetized due to the large perpendicular interfacial magnetic anisotropy induced by two FeB/MgO interfaces. The film was patterned into cylindrical pillars with a diameter from 200 nm to 400 nm by e-beam lithography. The magnetoresistance (MR) ratio is around 25% and the resistance-area (RA) product is $1.7 \Omega\mu\text{m}^2$. The magnetic field dependence of Q factor and total emission power of the STOs with different diameters are shown in Figure 2, where the bias voltage was -260 mV for all plots. The Q factor and emission power fluctuate with the magnetic field. It is clear that the 300-nm-diameter STO has the largest Q factor and the emission power among these samples. The maximum Q factor is as high as 602 at 310 mT, and the largest emission power is $1.42 \mu\text{W}$ at 335 mT. The size dependence of Q factor and emission power may come from the change of the perpendicular magnetic anisotropy and the impedance mismatch.

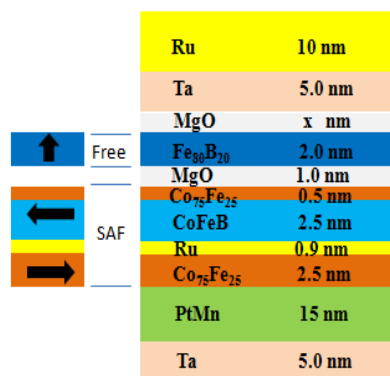


Figure 1: Schematic stacking structure of spin-torque oscillator.

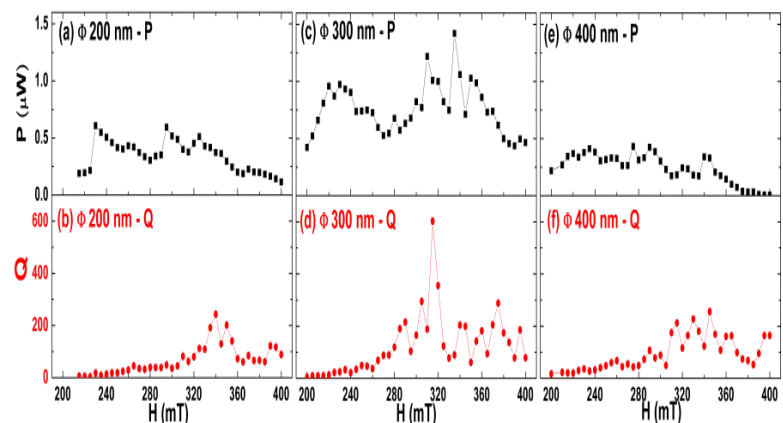


Figure 2: The magnetic field dependence of Q factor and total emission power with different diameters.

References

- [1] A. M. Deac, et al, Nat. Phys. 4, 803 (2008).
- [2] H. Kubota, et al, Appl. Phys. Express 6, 103003 (2013).
- [3] H. Maehara, et al, Appl. Phys. Express 6, 113005 (2013).