Nanoscale physics

High-power AFM based Spin Hall nano-oscillator

O.R. Sulymenko*, O.V. Prokopenko

Faculty of RadioPhysics, Electronics and Computer Systems, Taras Shevchenko National University of Kyiv, Volodymyrska str. 64/13, Kyiv 01601, Ukraine.
**E-mail: olgasulymenko@gmail.com*

In this paper we propose to use a thin layer of antiferromagnetic (AFM) material with easy-plane anisotropy, where the magnetization vectors $\mathbf{M_1}$, $\mathbf{M_2}$ of the AFM sublattices are canted inside the easy plane by a bulk Dzyaloshinskii-Moriya interaction (DMI) as a free layer (FL) of a nano-scale spin-Hall oscillator (SHO). The bulk DMI inside the AFM layer leads to the canting of the magnetizations $\mathbf{M_1}$ and $\mathbf{M_2}$ of the sublattices, thus creating a small net magnetization $\mathbf{M_{DMI}}$. Current-driven rotation of the net magnetization could lead to the generation of high-power THz-frequency AC signal.

We investigated theoretically Hematite/Platinum bi-layered structure placed into a microwave/THz-frequency resonator. A similar device with usual (not canted) AFM without DMI and, correspondingly, without a net magnetization was described in details in [1]. To estimate the power of the generated AC signal we used the approach described in our previous work [2]. The power emitted by the SHO can be written as $P = P_m Q V / V_{eff}$, where $P_m \sim f V M_{DMI}^2$ is the characteristic power generated in the SHO FL, V is the volume of the FL, V_{eff} is the effective volume of the microwave/THz resonator coupled to the SHO, and Q is the Q-factor of this resonator. We calculate an output signal power, which can be extracted from a Hematite/Platinum SHO with a rectangular dielectric or metal resonator, as well as the power emitted into a free space and received via the inverse spin-Hall effect. Our estimations show that the output signal power extracted from a SHO with a rectangular dielectric resonator generating at the frequency of f=1 THz could reach P~7μW. Publication is based on the research provided by the grant support of the State Fund for Fundamental Research and support from KNU (grant 16BF052-01) and NASU.

1. *Khymyn R., Lisenkov I., Tiberkevich V., Ivanov B., Slavin A.,* Antiferromagnetic THzfrequency Josephson-like Oscillator Driven by Spin Current//arXiv:1609.09866.

2. *Prokopenko O., Bankowski E., Meitzler T., Tiberkevich V., and Slavin A.* Spin-Torque Nano-Oscillator as a Microwave Signal Source// IEEE Magn. – 2011–**2.**–P.3000104