Observation of standing spin-wave modes in a YIG slab using lock-in thermography

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Recently, imaging of the thermal heating for propagating spin waves (SWs) was demonstrated by using infra-red (IR) camera as an effective tool for studying the spin-waves damping phenomena [1, 2]. Using the high sensitive infra-red (IR) camera, the spatial thermal heating profile has been imaged in the ferrimagnetic insulating sample. However, for a detailed analysis of the interaction between spin and heat is required an advanced thermography method such as lock-in thermography (LIT) [3]. In this work, we have used the LIT technique for the magnetostatic backward volume wave (MSBVW) standing spin-wave mode excited in a polycrystalline yttrium iron garnet (YIG) square slab (8mm × 8mm × 1mm) enabling more sensitive and spatially resolved heat emission imaging corresponding to standing spin-wave mode patterns.

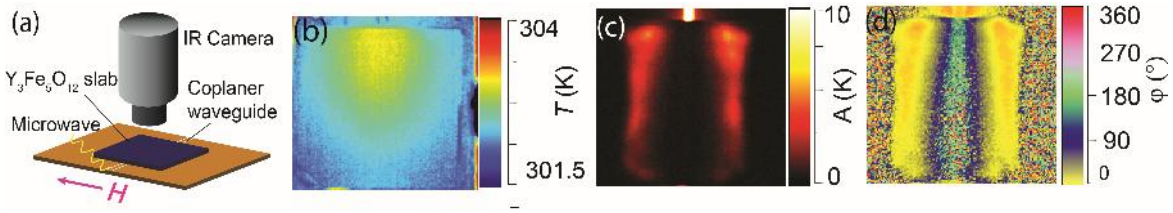

Fig. 1 (a) Schematic of the experimental setup, (b) temperature image of continuous excitation T(K); (c) Lock-in amplitude (A) and (d) phase (φ) image for a MSBVW standing spin-wave mode excited in the YIG polycrystalline slab. (f_{MW} = 4.43 GHz, H = 1050 Oe, lock-in frequency (f_{LI}) = 15 Hz)

The YIG slab was placed on a coplanar waveguide to excite the MSBVW spin waves and in-plane static magnetic field H = 1050 Oe was applied. At each spin-waves excited frequencies, temperature rises due to the SWs damping are captured. As shown in Fig.1 (b), the spatial thermal temperature profile for continuous spin-wave excitation is smeared by heat conduction. In this work, by using the LIT technique, as shown in Fig. 1 (c) and (d), where the frequency domain Fourier transformed thermal heating profile (phase and amplitude) can be obtained, we have observed clear images of MSBVW standing spin-waves modes in the YIG sample, respectively. The observed heat emission pattern is well understood by standing spin-wave mode having a node at the center in parallel to the applied field showing good agreement with an exponential damping factor in the propagating direction. The observation different standing spin-wave modes will be presented.

References

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