Waveguides as short-wavelength spin wave sources for magnonic signal processing

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Spin waves offer intriguing possibilities for transmitting and processing information in future electronics [1][2][3]. The proposed devices require efficient creation of submicrometer-wavelength spin waves at frequencies well above 10 GHz, which is a challenging task.

Coplanar and microstrip waveguides can be used on both metallic ferromagnets and on magnetic insulators. We designed, simulated, fabricated waveguides on top of CoFe films, with widths going all the way down to 250 nm. We used micro-Brillouin Light Scattering measurements to characterize the emitted spin waves. Asymmetric coplanar waveguides along the film edge were superior in generating short-wavelength spin waves and narrower waveguides outperformed wider ones at frequencies above 10 GHz. We found reasonable agreement between measured spin wave intensity distributions (Fig 1b) and the distributions predicted by micromagnetic simulations (Fig 1a). Discrepancies between measurements and simulations can be attributed to the different microwave characteristics of the waveguides.

Due to the inherently delocalized field distributions of waveguides, and also to the resistivity of narrow waveguides, they all show poor efficiency for generating spin waves below λ=3 μm and f > 10 GHz. This means that the intensity of the generated spin waves for a given input power drops quickly for the frequency / wavelength range which is most relevant for emerging applications. Efficient magnonic sources in this regime may have to use a different mechanism for spin wave generation, such as spin-orbit torque.

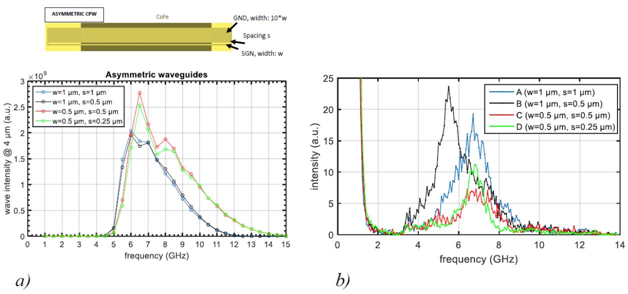

Figure 1. Simulated (a) and measured (b) intensity distributions for an asymmetric waveguide. The inset shows the waveguide geometry

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