Nanomagnonics : from metals to insulators

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Collective spin excitations in magnetically ordered materials have gained a broad interest in recent years. Here spin waves (magnons) in magnetic nanostructures have formed a particular focus as they allow one to transmit and process microwave signals at the nanoscale. For a long time, ferromagnetic metals were exploited to prototype nanomagnonic waveguides and magnonic crystals which provide an unprecedented control over spin-wave band structures [1]. To harvest the advantages and low-energy consumption which a magnonics-based technology could offer materials of low spin-wave damping are required however. Correspondingly, magnetic insulators become important in the research field. We will review and discuss recent advances based on ferromagnetic insulators with and without Dzyaloshinsky-Moriya interaction that allow one to tailor spin-wave properties at the nanoscale via chiral spin structures [2] or nanostructuring (Fig. 1). We acknowledge support by the DFG via Nanosystems Intiative Munich, project GR1640/5-2 and the Transregio TRR80 ”From electronic correlations to functionality” (project F7). The Swiss National Science foundation (SNSF) funds magnonics research on skyrmion-hosting materials via the sinergia network ”Nanoskyrmionics” (grant CRSII5-171003).

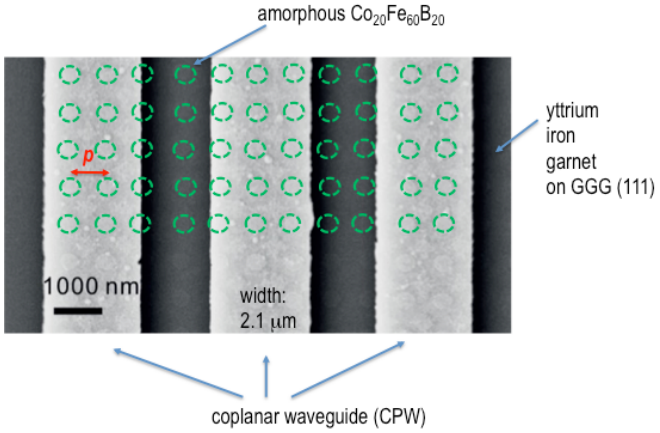

Fig. 1: Thin film of insulating ferromagnetic yttrium iron garnet (YIG) with an integrated array of ferromagnetic disks nanopatterned from CoFeB (period p = 800 nm, highlighted by dashed circles). The coplanar waveguide allows one to excite exchange-dominated spin waves propagating through YIG [3].

[1] A.V. Chumak, A.A. Serga, and B. Hillebrands, *Magnonic crystals for data processing*, J. Phys. D: Appl. Phys. **50**, 244001 (2017)

[2] M. Garst, J. Waizner, and D. Grundler, *Collective spin excitations of helices and magnetic skyrmions: review and perspectives of magnonics in non-centrosymmetric magnets*, J. Phys. D: Appl. Phys., in press (2017), https://doi.org/10.1088/1361-6463/aa7573

[3] Haiming Yu et al., *Approaching soft X-ray wavelengths in nanomagnet-based microwave technology*, Nature Commun. **7**, 11255 (2016)