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Electrically driven magnetization dynamics in yttrium iron garnet[1]

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Creation and manipulation of magnetization states by spin-orbital torques are important for novel spintronics applications. Magnetic insulators were mostly ignored for this particular purpose, despite their low Gilbert damping, which makes them outstanding materials for magnonic applications and investigation of nonlinear spin-wave phenomena. Here, we demonstrate the propagation of spin-wave modes in micro-structured yttrium iron garnet ($Y_3Fe_5O_{12}$,YIG) stripes. Spin waves propagating along the long side of the stripe are detected by means of spatially-resolved Brillouin light scattering (BLS) microscopy. The propagation distance of spin waves is determined in the linear regime, where an exponential decay of 10 μm is observed[3]. We also explored the possibility of driving magnetization dynamics with spin Hall effects (SHE) in bilayers of YIG/Pt microstructures. For this purpose we adopted a spin-transfer torque ferromagnetic resonance (ST-FMR) approach. Here a *rf* charge current is passed through the Pt layer, which generates a spin-transfer torque at the interface from an oscillating spin current via the SHE. This gives rise to a resonant excitation of the magnetization dynamics. In all metallic systems the magnetization dynamics is detected via the homodyne anisotropic magnetoresistance of the ferromagnetic layer. However, since there is no charge flowing through ferromagnetic insulators there is no anisotropic magnetoresistance. Instead, we show that for the case of YIG/Pt the spin Hall magnetoresistance can be used. Our measured voltage spectra can be well fitted to an analytical model evidencing that the ST-FMR concept can be extended to insulating systems[4]. Furthermore, we employ spatially-resolved BLS spectroscopy to map the ST-FMR driven spin dynamics. We observe the formation of a strong, self-localized spin-wave intensity in the center of the sample[5]. This spin-wave 'bullet' is created due to nonlinear cross coupling of eigenmodes existing in the magnetic system, which is confirmed by micromagnetic simulations.

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