Large voltage tuning of Dzyalonshinskii-Moriya Interaction: a route towards dynamic control of skyrmion chirality.

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Electric control of magnetism is a pre-requisite for efficient and low power spintronic devices. More specifically, in heavy Metal/Ferromagnet/Insulator heterostructures, voltage gating has been shown to locally and dynamically tune magnetic properties like interface anisotropy and saturation magnetization [1,2]. However its effect on interfacial Dzyaloshinskii-Moriya Interaction (DMI) [3], which is crucial for the stability of magnetic skyrmions, has been challenging to achieve and therefore has not been reported yet for ultrathin films.

Here, we demonstrate 140% variation of DMI with electric field in sputter deposited Ta/FeCoB/TaOx trilayers through Brillouin Light Spectroscopy (BLS). We further show a monotonic variation of DMI and skyrmionic bubble size with electric field by polar-Magneto-Optical-Kerr-Effect microscopy. Our experiments show an unprecedented electric field efficiency for DMI β_{DMI} = 700fJ/Vm. The efficient DMI manipulation with voltage thus establishes an additional degree of control over skyrmions and spin orbitronic based devices. We anticipate through our observations that a sign reversal of DMI with electric field is possible, leading to a chirality switch. This dynamic engineering of DMI lays the foundation towards programmable skyrmion based memory or logic devices.

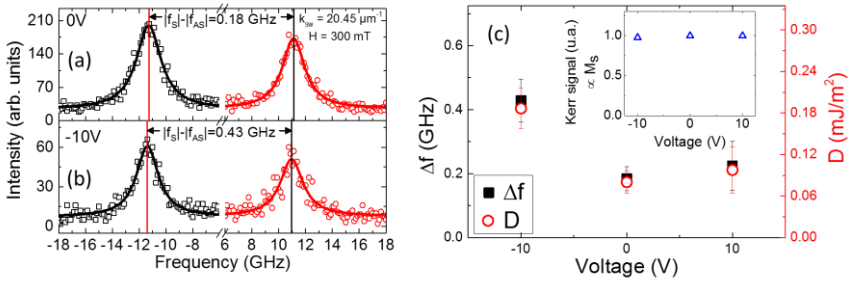

Figure 1: BLS spectra (open symbols) and Lorenztian fits (lines) measured under 0V (a) and -10V (b). The frequency difference Δf changes by 140% at -10V. (b) Variation of frequency difference Δf and deduced interfacial DMI as a function of applied voltage.

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[2] M. Schott et al.,The Skyrmion Switch: Turning Magnetic Skyrmion Bubbles on and off with an Electric Field. NanoLett., **17**, 3006 (2017)
[3] U. K. Robler, A. N. Bogdanov, and C. Pfleiderer, Spontaneous skyrmion ground states in magnetic metals. Nature **442**, 797 (2006)