Surface acoustic wave manipulation of magnetic domain walls and skyrmions

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Surface acoustic waves (SAWs) are potentially interesting for energy-efficient control of magnetic domain wall (DW) and skyrmion motion via magneto-elastic coupling [1]. We have shown previously that domains in a Ta(5.0)/Pt(2.5)/Co(1.1)/Ir(1.5)/Ta(5.0) thin film (thicknesses in nm) deposited by dc magnetron sputtering onto a 128° Y-cut lithium niobate susbtrate are preferentially nucleated at the anti-nodes of an applied standing SAW [2]. One issue however is that SAW-induced heating may also contribute to magnetization reversal processes. Thus, we measured the heating of a SAW device using an on-chip Pt film as a thermometer (Fig. 1(a,b)). Interdigitated transducers of center frequency 48 MHz were patterned either side of a strip of Ta(5.0)/Pt(2.5)/Co(0.9)/Ta(5.0) thin film (thicknesses in nm, Fig. 1(c)).

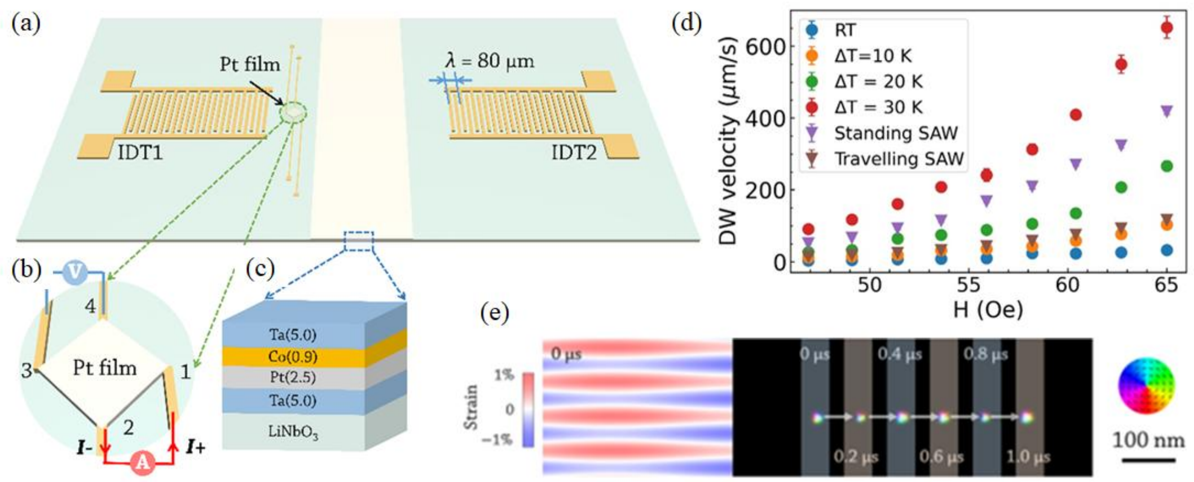

Fig. 1: Schematic of the SAW device (a) and the on-chip Pt thermometer (b). (c) Structure of the Ta/Pt/Co/Ta film. (d) DW velocity at different temperatures or in the presence of SAWs, plotted against the applied magnetic field. (e) Snapshot of skyrmion motion in the presence of longitudinal travelling SAW and transverse standing SAW.

Measurements of DW velocity by Kerr microscopy (Fig. 1(d)) show that with a 10 K temperature increase and no SAWs applied, the velocity increases from 33±3 μm/s to 104±8 μm/s at an external field of 65 Oe. The temperature rises by 10 K and DW motion is enhanced (418±8 μm/s) in the presence of standing SAWs, but not travelling SAWs [3]. We have performed micromagnetic simulations to examine the effect of SAWs on DW and skyrmion velocities in this material [4,5]. In Fig. 1(e) we combine a longitudinal travelling SAW and a transverse standing SAW to transport skyrmions by exploiting a balance of SAW-induced forces.

References

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