Seminar : Yamanoi Kazuto

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Magnon-phonon coupling using the GHz-range surface acoustic wave

Abstract Recent studies have highlighted the importance of magnon–phonon coupling between spin waves and surface acoustic waves (SAWs) for the development of magnon-based logic devices. This coupling emerges at the intersection points of the dispersion relations of magnons and SAWs, making it essential to investigate both the resonance conditions and the coupling strength.

In this seminar, we present a multiple-overtone SAW device that enables the evaluation of multiple intersection conditions within a single device. This approach allows direct visualization of magnon–phonon dispersion relations at different SAW excitation frequencies.

The device consists of a pair of interdigital transducers (IDTs) fabricated on a LiNbO3 piezoelectric substrate using a conventional lift-off technique. A Heusler ferromagnetic alloy thin film, Co2FeSi/V, known for its high spin polarization, was deposited between the IDTs by molecular beam epitaxy. Transmission measurements were performed using a vector network analyzer. The fundamental SAW frequency of approximately 0.193 GHz agrees well with the expected excitation frequency based on the IDT period of 20 um. Notably, higher-order SAWs up to the 29th overtone (~5.6 GHz) were successfully excited.

By measuring the magnetic-field dependence of SAW propagation, we observed clear signatures of magnon–phonon coupling at each SAW resonance. A heatmap of the dispersion relations as a function of SAW frequency and in-plane magnetic field parallel to the SAW propagation direction reveals the systematic relationship between resonance field and SAW frequency, directly visualizing the intersection conditions between magnons and phonons in the Co2FeSi film.

In the presentation, we will also discuss our recent results on magnon–phonon coupling using different material systems.

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