Surface Acoustic Wafes in Magnetic Phononic Crystals

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Quantum communication and information processing strongly benefit from the coupling between different quasi-particles, offering complementary advantages. Magnetoelastic materials inherently allow for direct coupling between magnetization dynamics and quantized lattice vibrations, called phonons. Near the ferromagnetic resonances, phonons may thus trade energy and angular momentum with uniformly precessing spin waves, called magnons, and enable transduction of information from magnetic to phononic mode, thereby paving the way for long-range transport of magnetic information without the need of magnetic material. Here, we employ tailored magnetic-nonmagnetic heterostructures, which simultaneously act as cavities for standing strain waves, to bring selective phonons and magnons into resonance. These Co films with Pt seed layers show extended linewidth and reduced amplitude of the phonon-resonant FMR lines, providing a hallmark of energy and angular momentum exchange. Complementarily, by theoretical modeling and ultrafast coherent phonon spectroscopy, we identify the responsible acoustic phonons as standing strain waves in the combined Co and Pt structure. We find a better crystal quality, thereby having a high magnetocrystalline anisotropy in conjunction with a large magnetoelastic coupling constant as a prerequisite for efficient magnon-phonon coupling of this type. Such resonant enhancement of magnon-phonon coupling in CMOS-compatible material provides an ideal material platform for future quantum transducers.

References

[1] Authors, Journal, (2024)
[2] Authors, Journal, (2026)