Recent years have shown a growth of interest in multiferroic and magnetostrictive devices. In order to support these new applications, a variety of new magnetostrictive materials and magnetostrictive / piezoelectric heterostructures are being developed. In order to fully integrate these novel materials, new methods are needed to precisely characterize their piezomagnetic and magnetoelastic coefficients at frequencies and magnetic fields of interest to device designers.

The purpose of this research is to understand the coupling mechanisms between mechanical and spin degrees of freedom in multiferroic systems. To achieve this goal, our system is a composite multiferroic heterostructure where a ferromagnet is coupled with a piezoelectric material. The key concept hinges on the fact that a mechanical vibration in a piezoelectric material can be translated into a magnetic field through a change in the magneto-crystalline anisotropy of an attached ferromagnet. This alters the internal magnetic field the magnet experiences due to its anisotropy. This change can then be exploited to generate ferromagnetic resonance. By applying models for ferromagnetic resonance and acoustic excitation of spin waves, we can use the data collected in these resonance studies to determine piezomagnetic and magnetoelastic coefficients for the materials used in our system.

Measurements of our devices have allowed for the extraction of the piezomagnetic coefficient of nickel thin films at a number of frequencies and over a wide range of applied magnetic fields. The extracted coupling closely aligns with literature values. Future experiments will investigate more complex material systems and will attempt to extend these techniques to single phase multiferroics, where they could allow for us to quantify in-plane magnetoelastic coefficients.

Keywords: Multiferroic, Acoustically Driven Ferromagnetic Resonance, Piezomagnetic Coefficient

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