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Magnetostriction measurements on thin films by a slotline ferromagnetic resonance technique (abstract)

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Magnetostriction measurements on thin films by a slot-line ferromagnetic resonance technique^{a)} (abstract)

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We report on a new technique for the determination of the linear magnetostriction constant of thin films. The technique uses the shift in ferromagnetic resonance (FMR) of a magnetostrictive sample upon application of an external stress. A circular thin film is deposited onto a fused quartz plate by ion beam sputter deposition. The plate is mounted in a cantilever configuration, with the film suspended over the junction of a slot-line/coplanar guided structure. The slot line provides a rf magnetic field normal to the film plane, tunable over the frequency range $0.1 \text{ GHz} < \nu < 20 \text{ GHz}$. Collinear dc and modulating magnetic fields are applied in the film plane. FMR spectra are obtained by measuring the differential power transmission with respect to modulation field by a phased locked-loop technique. The sample is stressed by deflecting the free end of the cantilever using a micrometer drive. Magnetostriction values are calculated from the measured field shift versus deflection using a model based upon a free-energy expression containing magnetoelastic and magnetic interaction energies. Since this method relies only upon measurement of the FMR field shift, we believe that it is a viable technique for measuring magnetostriction values, especially for very thin films.

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First principles approach to magnetostrictive hysteresis (abstract)

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A theoretical result for the magnetostriction λ in a ferromagnet is obtained via minimization of the energy with respect to the strains. This result contains terms which produce three experimentally observed hysteretic phenomena which hitherto have not been explained by existing models.¹ The first of these phenomena is liftoff. Although the magnetostriction starts at zero in the unmagnetized sample, it never returns to zero as the external magnetic field H is cycled around the magnetostrictive hysteresis loop. This liftoff phenomenon is seen experimentally in iron.¹ Second, the butterfly-shaped hysteretic variation of magnetostriction against magnetic flux density B now exhibits a negative derivative $\partial\lambda/\partial B$ just as the flux density decreases from its maximum in agreement with experiment. Thirdly, the λ -vs- H loops are in general wider loops than the λ -vs- B loops, which is quite noticeable experimentally in iron.¹ Thus, our new result exhibits all the characteristics of experimentally observed magnetostriction hysteresis.

¹M. J. Sablik and D. C. Jiles, *J. Appl. Phys.* **64**, 5402 (1988).