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Magnetostriction vs. Magnetoelastic Effects

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Magnetostriction and magnetoelastic coupling

Magnetostriction (from Wikipedia)

Magnetostriction is a property of [ferromagnetic](#) materials that causes them to change their shape when subjected to a [magnetic field](#). The effect was first identified in [1842](#) by [James Joule](#) when observing a sample of [nickel](#). This effect can cause losses due to frictional heating in susceptible ferromagnetic cores.

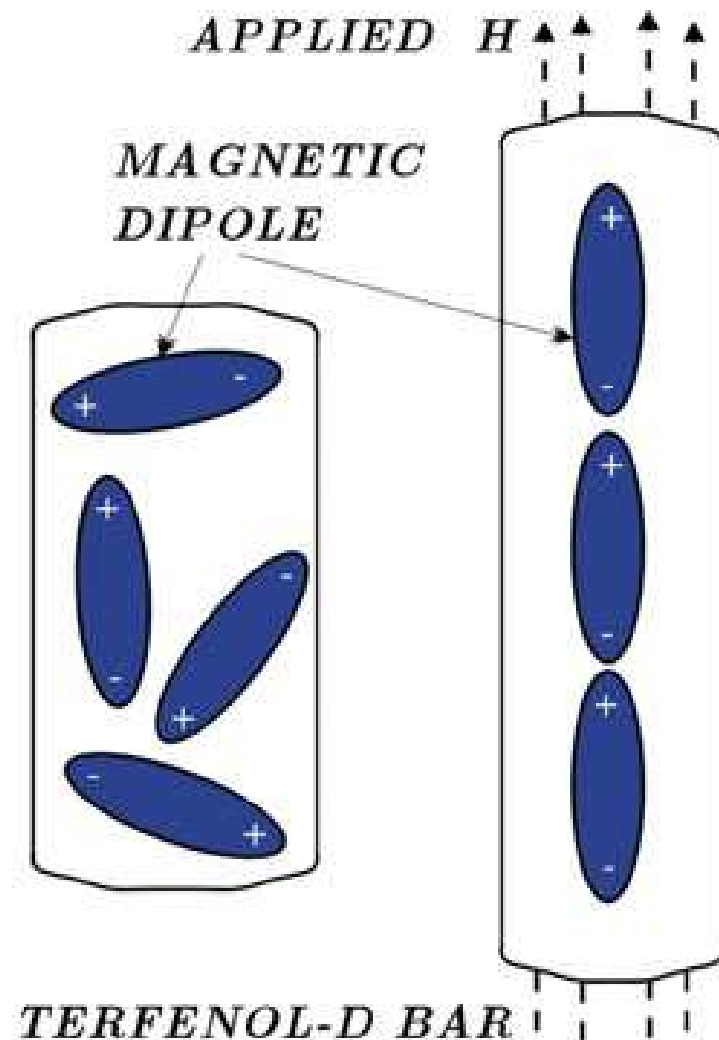
Magnetoelastic coupling (from [Sci-Tech Dictionary](#))

Magnetoelastic coupling -- The interaction between the magnetization and the strain of a magnetic material.

Magnetostriction (1)

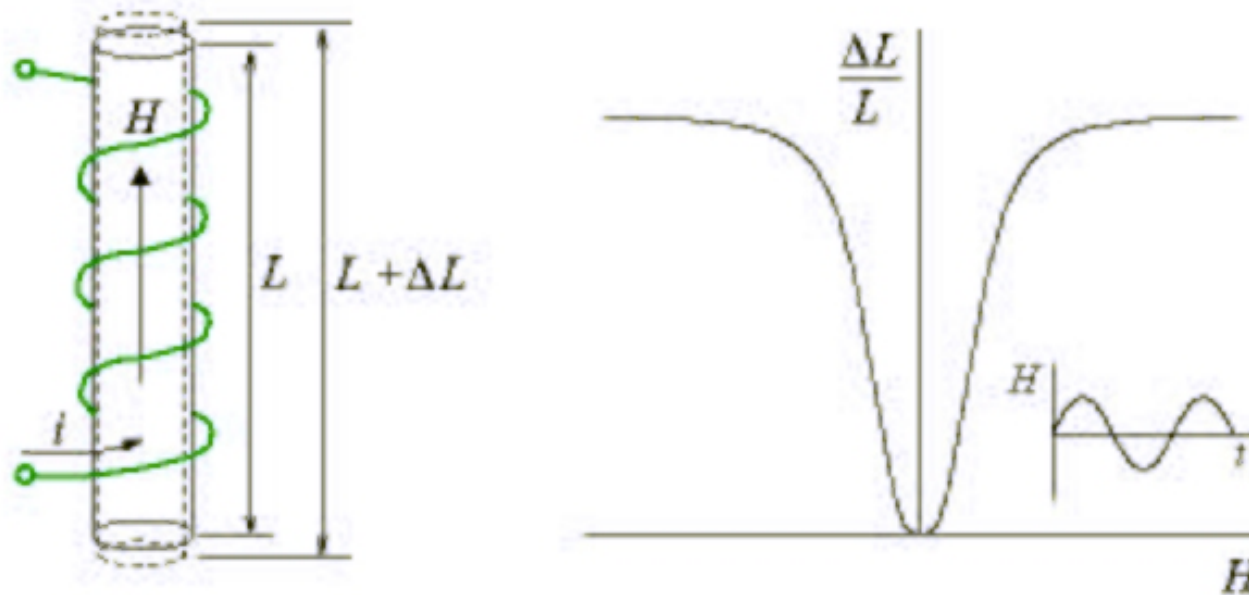
Magnetostriction is a phenomenon observed in all ferromagnetic materials. It couples elastic, electric, magnetic and in some situations also thermal fields and is of great industrial interest for use in sensors, actuators, adaptive or functional structures, robotics, transducers and MEMS.

A magnetostrictive material develops large mechanical deformations when subjected to an external magnetic field. This phenomenon is attributed to the rotations of small magnetic domains in the material, which are randomly oriented when the material is not exposed to a magnetic field. The orientation of these small domains by the imposition of the magnetic field creates a strain field. As the intensity of the magnetic field is increased, more and more magnetic domains orientate themselves so that their principal axes of anisotropy are collinear with the magnetic field in each region and finally saturation is achieved



Magnetostriction (2)

- ✓ **Magnetostriction** or **Joule magnetostriction** is a consequence of the **magnetoelastic coupling**. It pertains to the strain produced along the field direction and is the most commonly used magnetostrictive effect.
- ✓ Joule magnetostriction is the coupling between the magnetic and elastic regimes in a magnetostrictive material. Magnetostriction is **an intrinsic property of magnetic materials**.



Magnetoelastic effects

Direct Effects	Inverse Effects
Joule magnetostriction Change in sample dimensions in the direction of the applied field	Villari effect Change in magnetization due to applied stress
ΔE effect Magnetoelastic contribution to magnetocrystalline anisotropy	Magnetically induced changes in the elasticity
Wiedemann effect Torque induced by helical anisotropy	Matteuci effect Helical anisotropy and e.m.f. induced by a torque
Magnetovolume effect Volume change due to magnetization (most evident near the Curie temperature)	Nagaoka-Honda effect Change in the magnetic state due to a change in the volume