mecanon
Center for Nonlinear Mechanics
COPPE-POLI|UFRJ

COM783 – Mecânica de Sistemas Inteligentes: Materiais Inteligentes e Suas Aplicações

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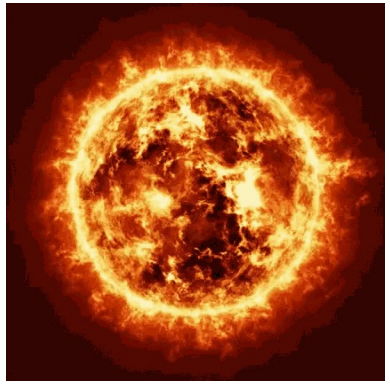
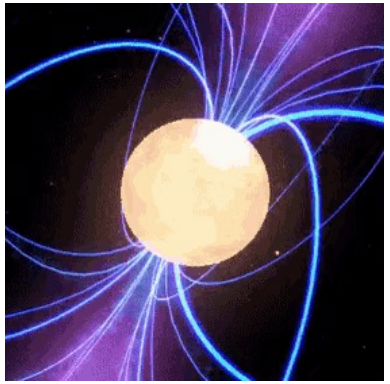
Universidade Federal do Rio de Janeiro (COPPE/UFRJ)

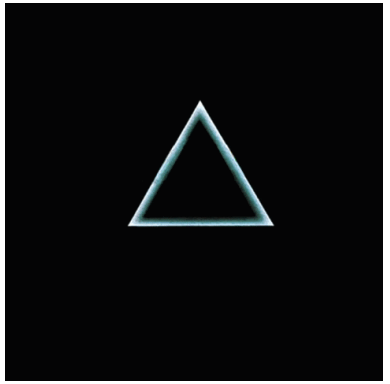
Programa de Engenharia Mecânica (PEM)

Materiais Inteligentes: Acomplamento Multifísico

Mecânico | Térmico | Elétrico | **Magnético** | Óptico



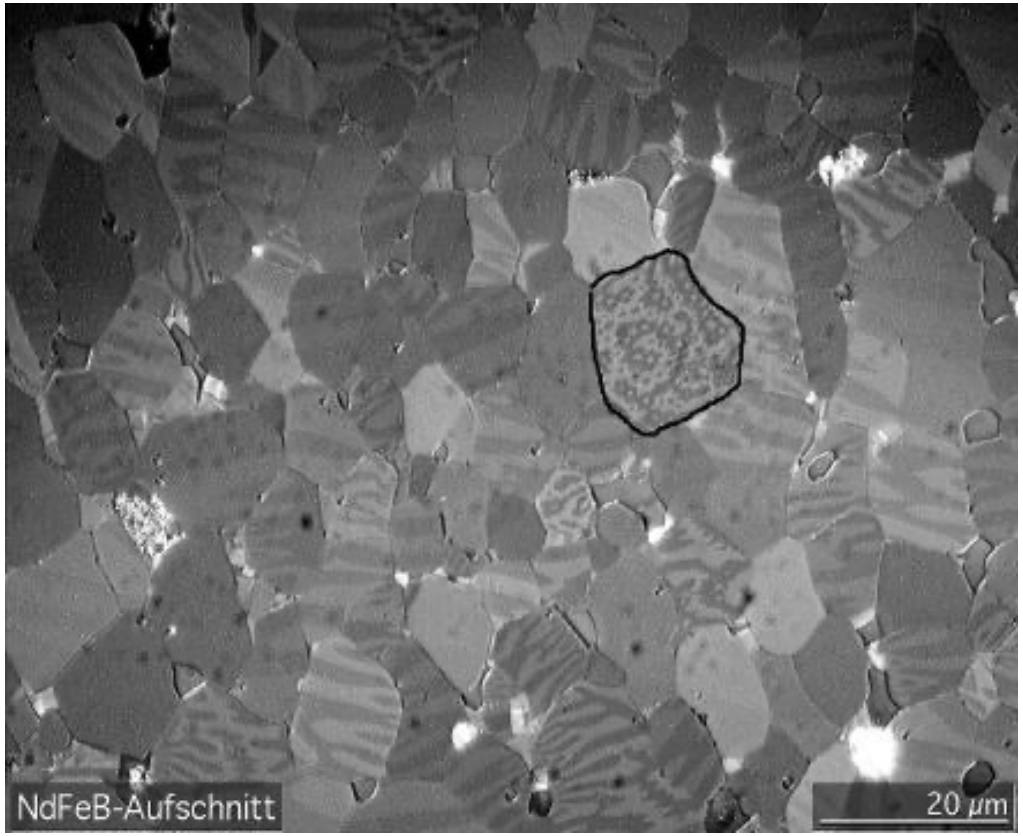




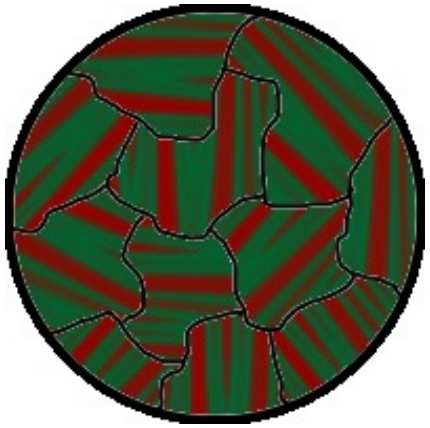
Magnetoestrictivos

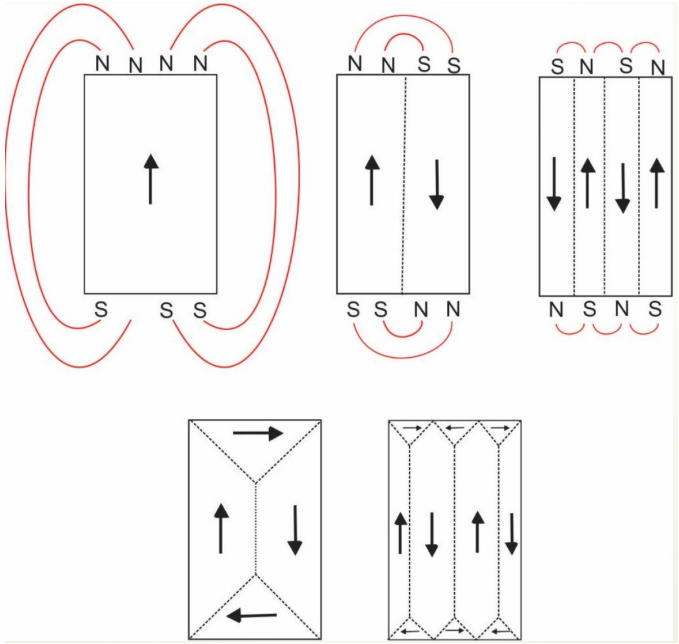
Fluidos Magnetoreológicos / Ferrofluidos

Domínios Magnéticos

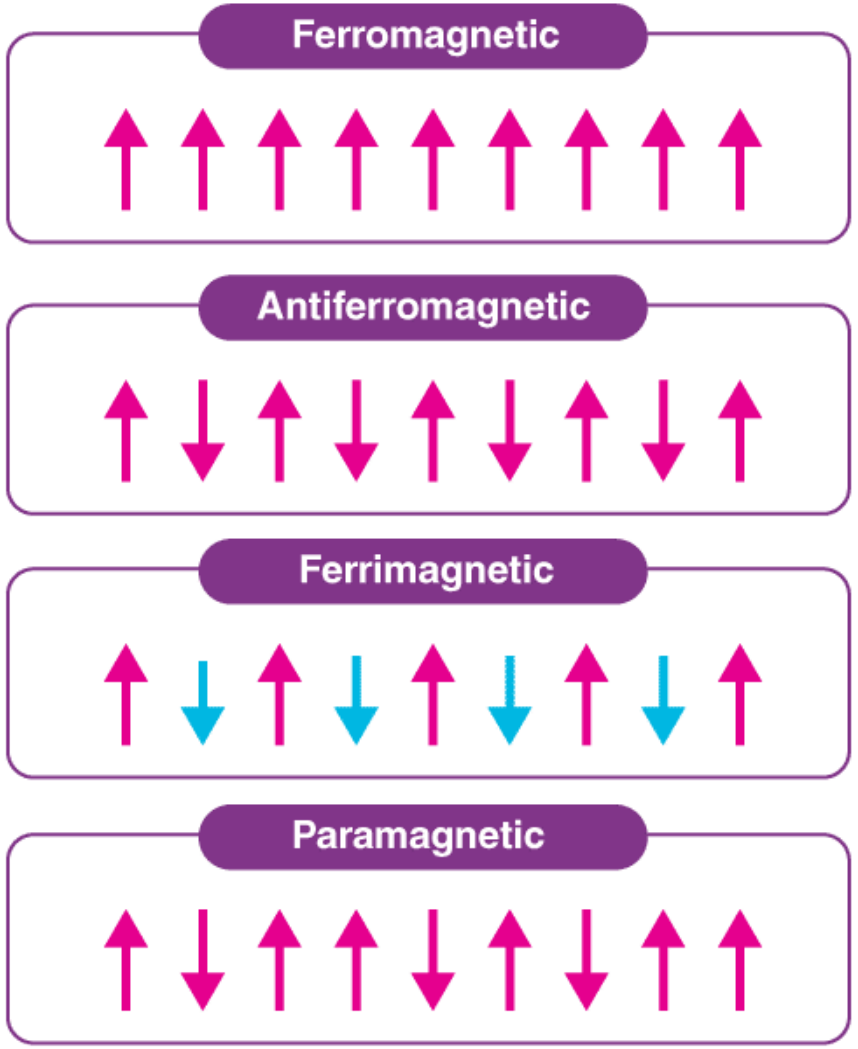


- → **Formam-se pelo alinhamento de elétrons desemparelhados (desbalanço de spin)**
- → **Mantem um baixo estado energético (minimizam energia magnetoestática)**





Domínios Magnéticos



→ Abaixo de T_c, spins são alinhados paralelamente em domínios magnéticos

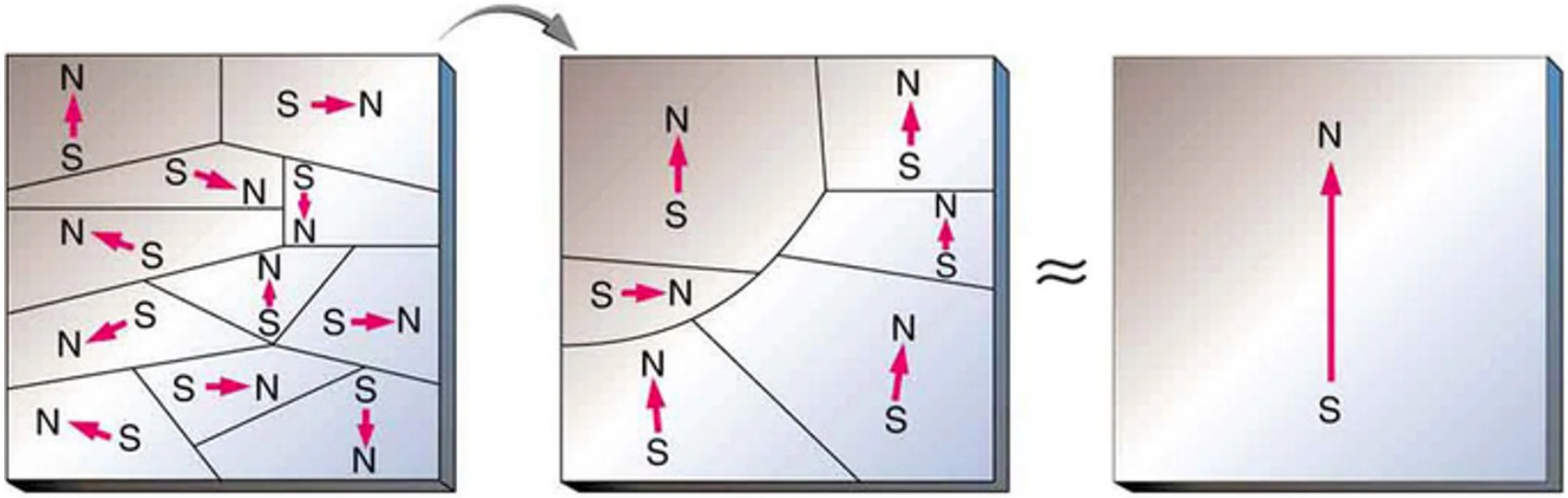
→ Abaixo de T_c, spins são alinhados anti-paralelamente em domínios magnéticos e se cancelam

→ Abaixo de T_c, spins são alinhados anti-paralelamente em domínios magnéticos, mas não se cancelam

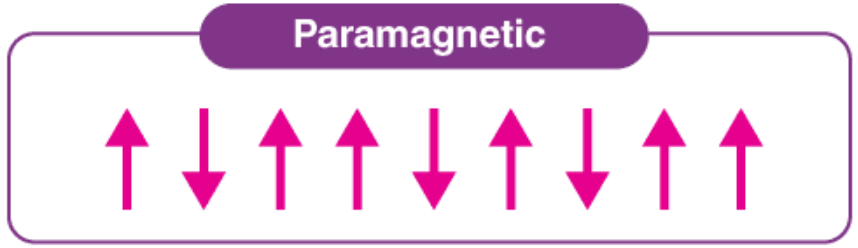
→ Spins são orientados de forma aleatória em qualquer temperatura

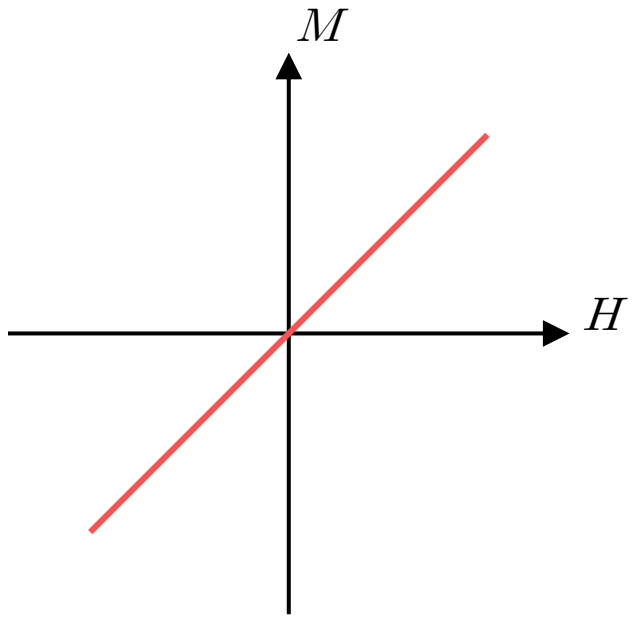
Domínios Magnéticos

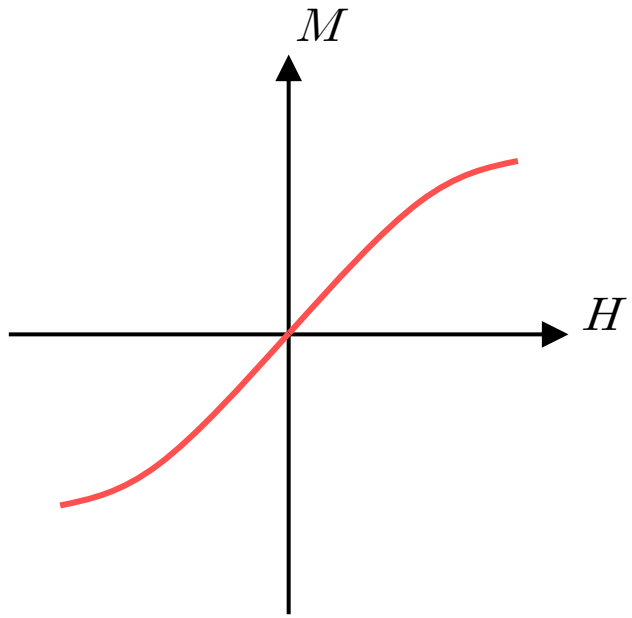
Domínios Magnéticos - Magnetização

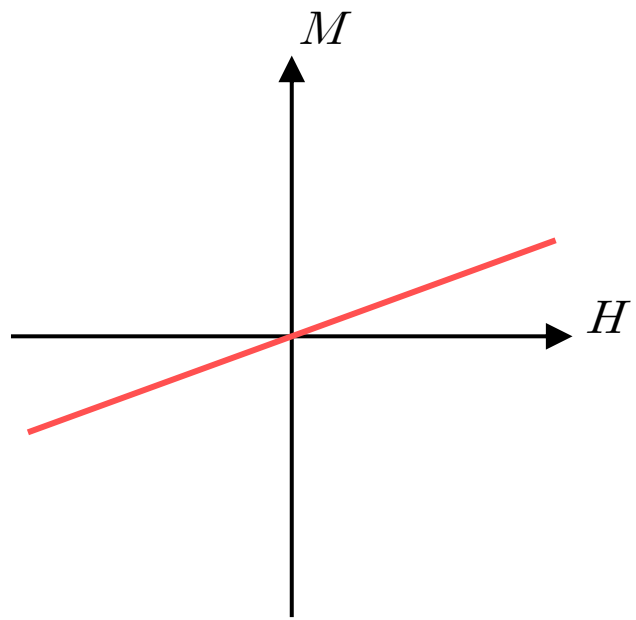


Domínios Magnéticos - Magnetização

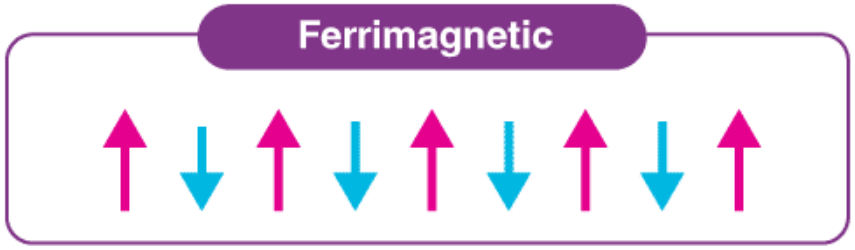


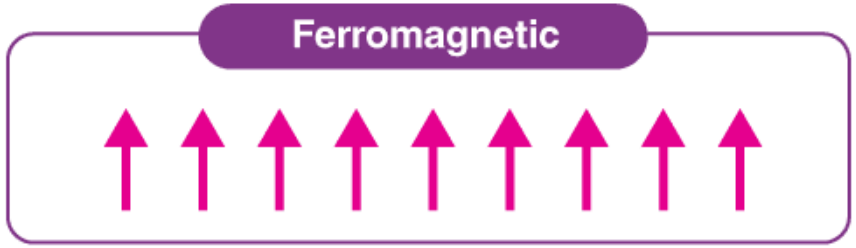


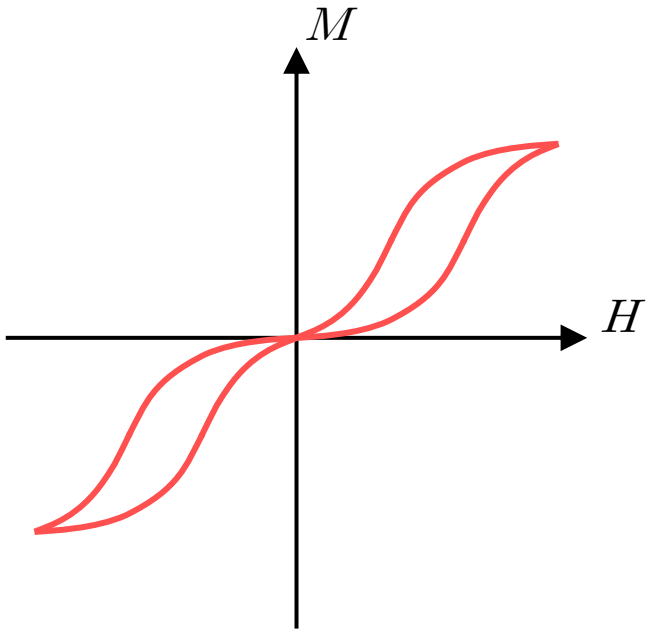


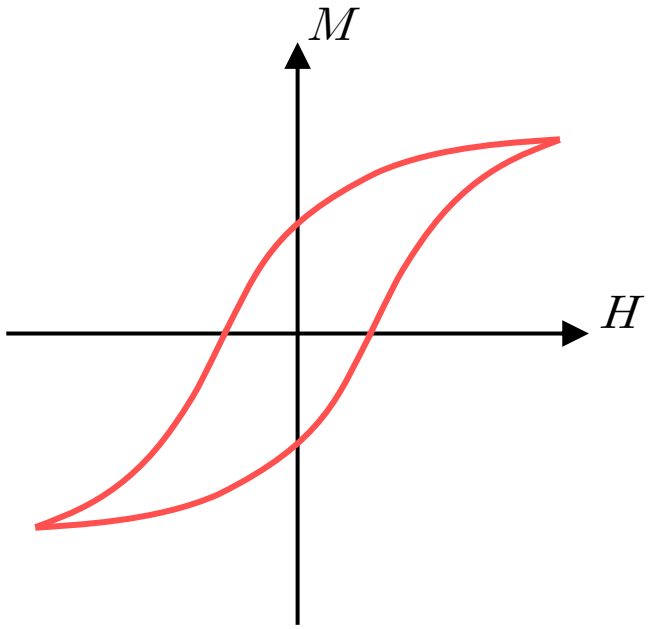


Domínios Magnéticos - Magnetização

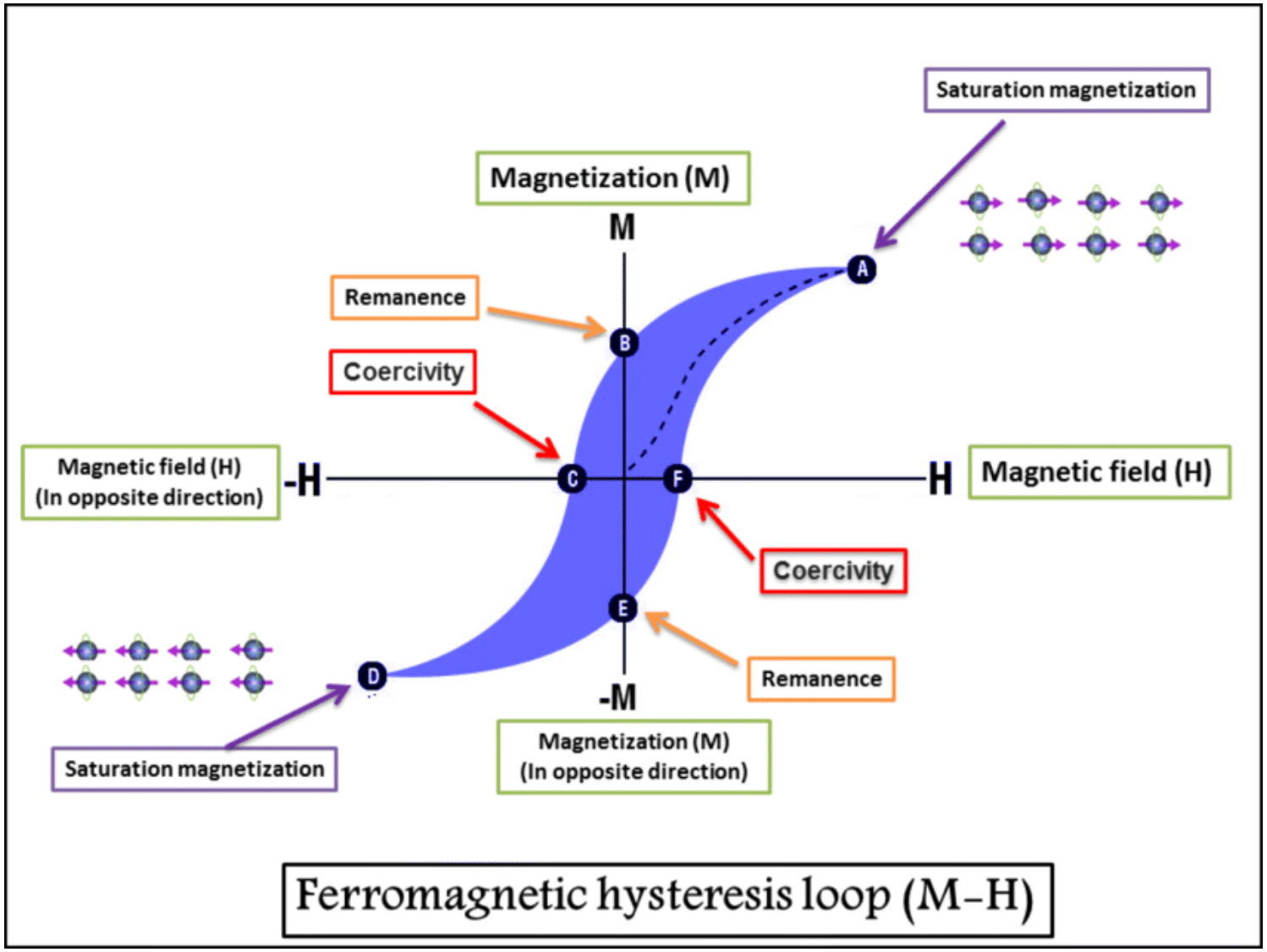






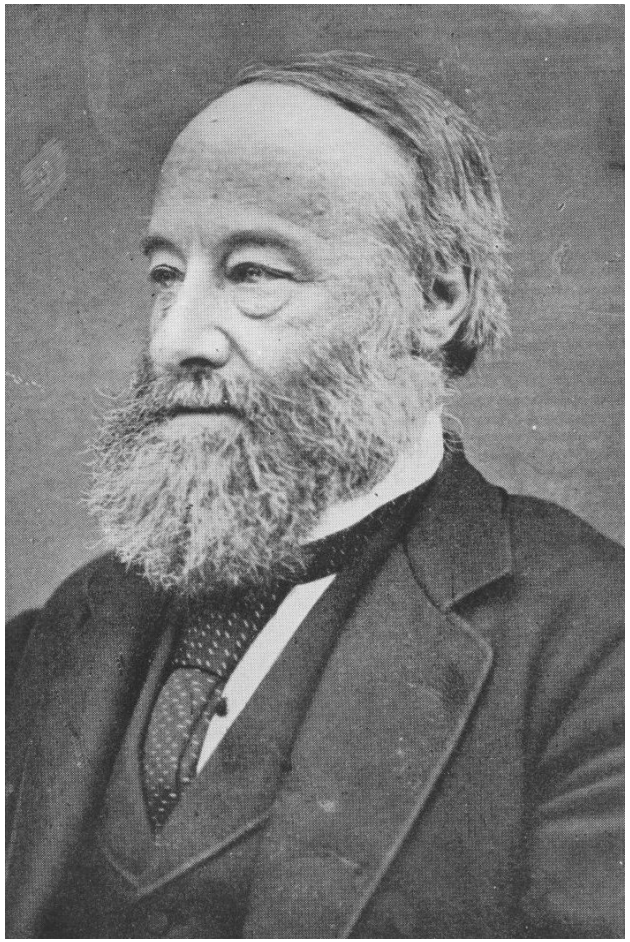


Domínios Magnéticos - Magnetização

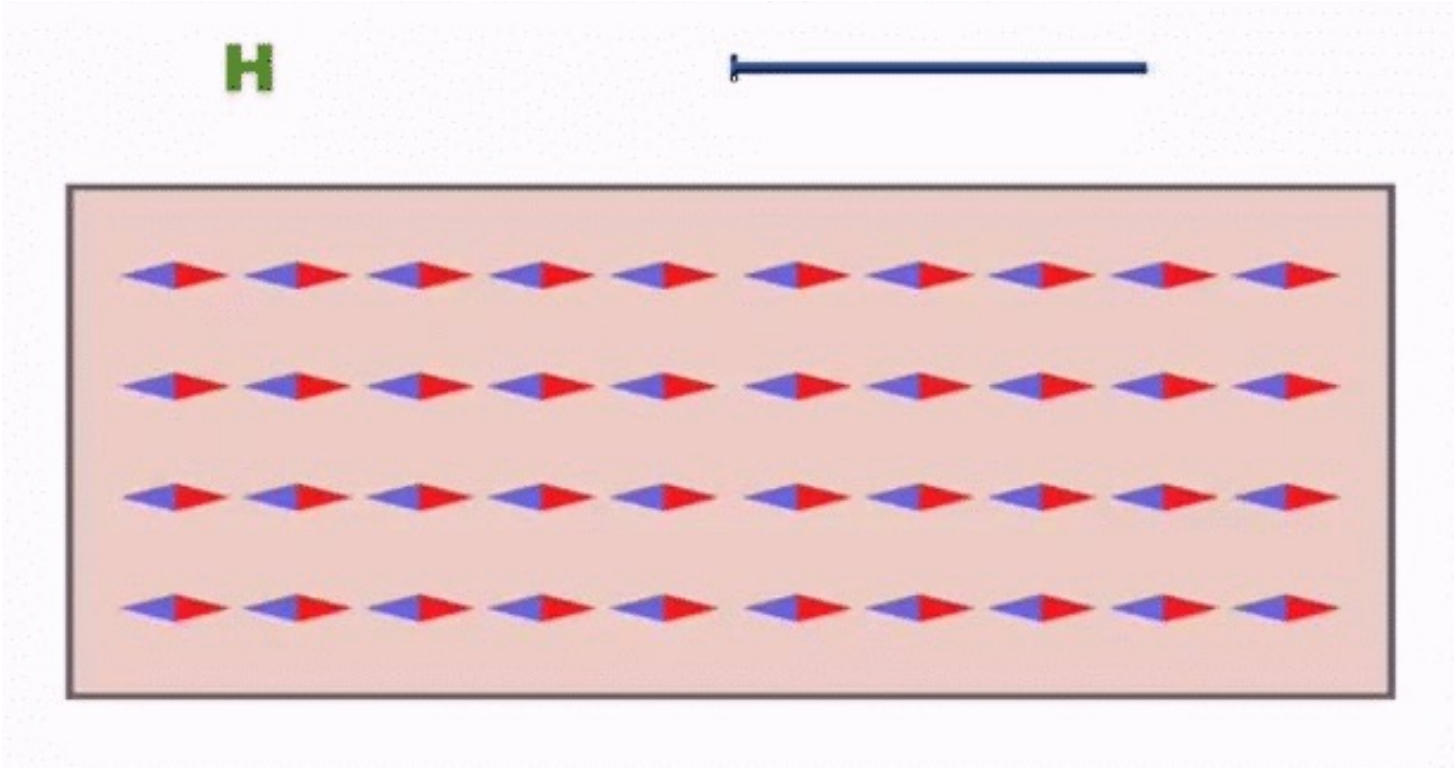


Magnetoestricção

James Joule (1818 – 1889)



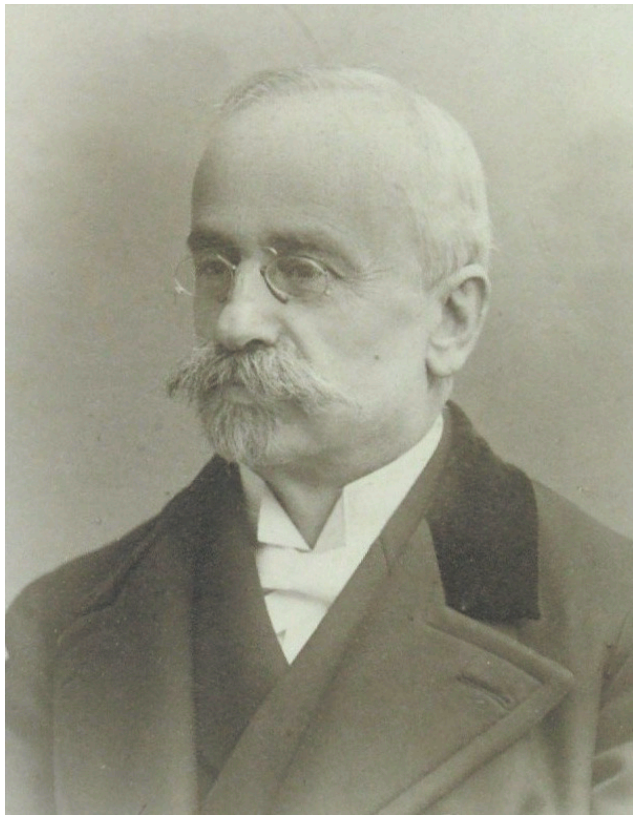
Efeito Direto (1842)



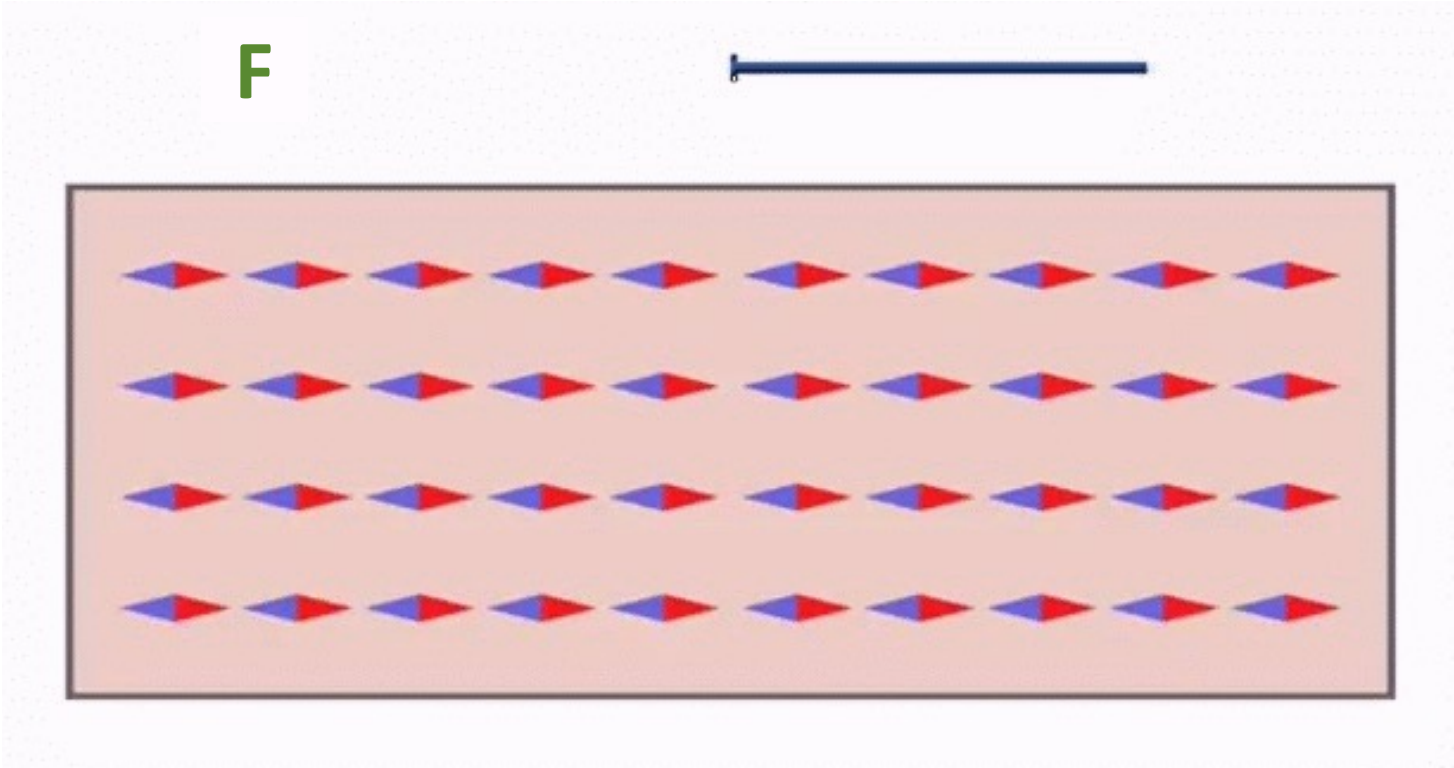
A deformação ocorre devivo à reorientação dos momentos magnéticos internos ao material

Magnetoestricção

Emilio Villari (1836 – 1904)



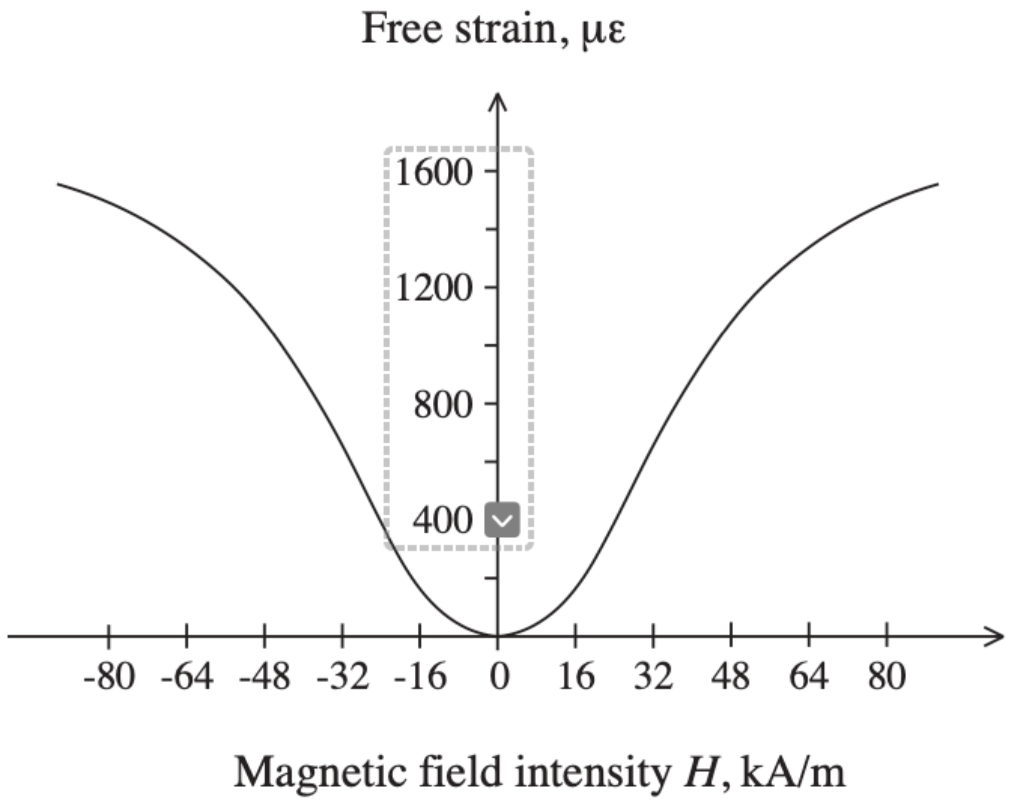
Efeito Inverso / Efeito Villari (1900)

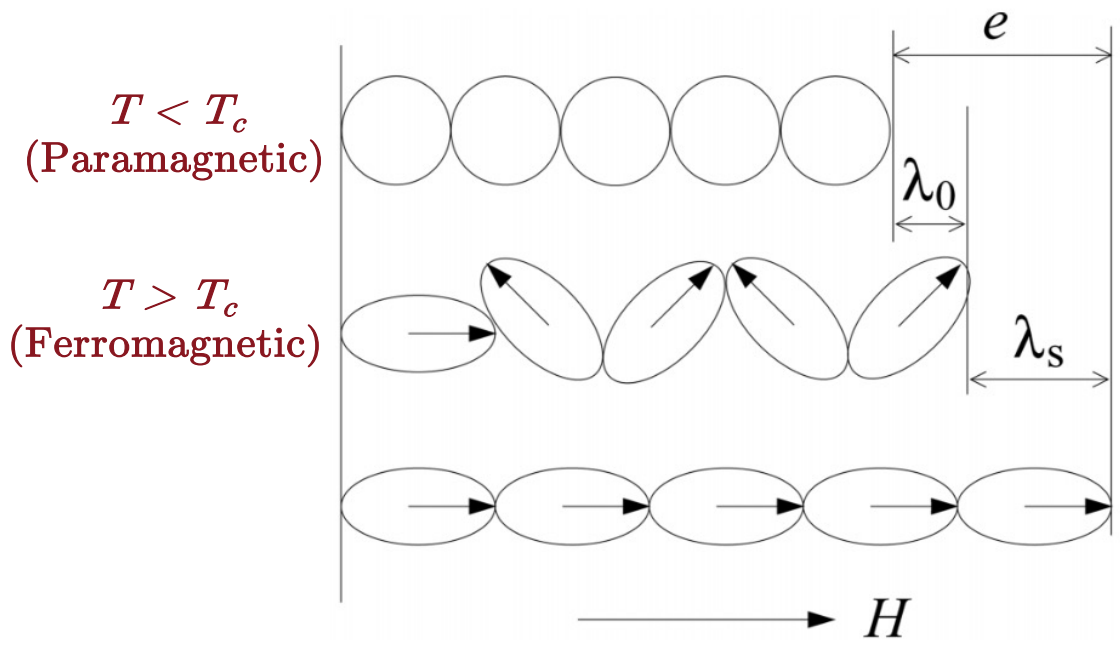


A deformação induz uma mudança na magnetização do material

Magnetoestricção

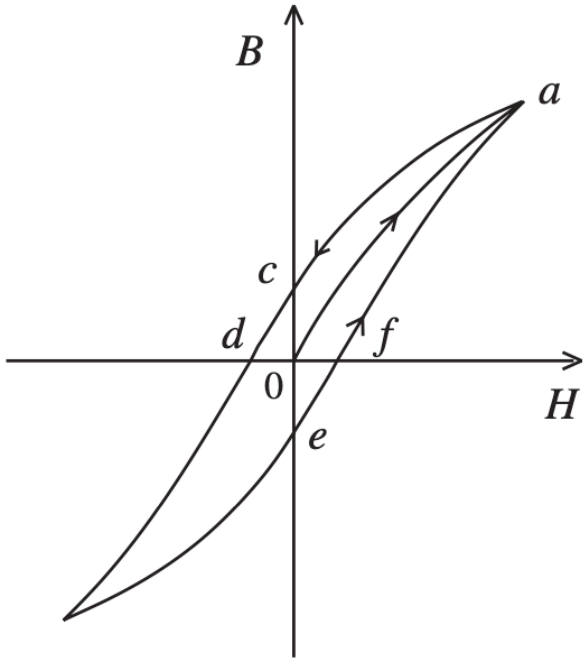
Comportamento Quasiestático

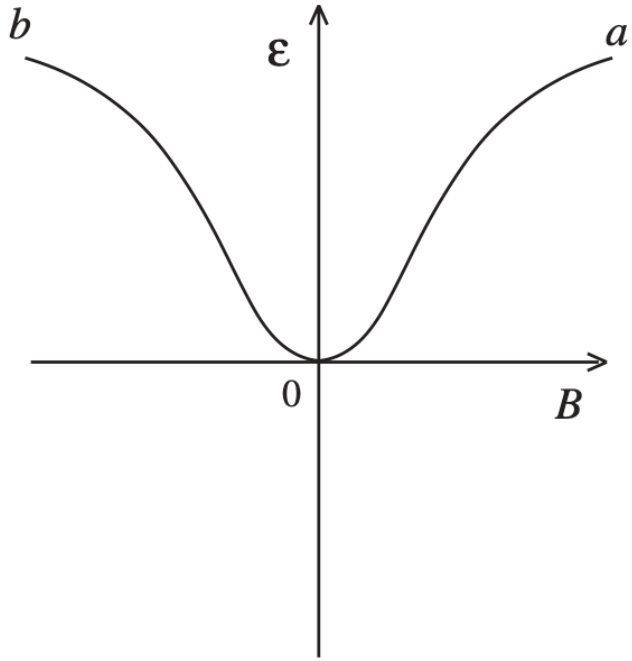


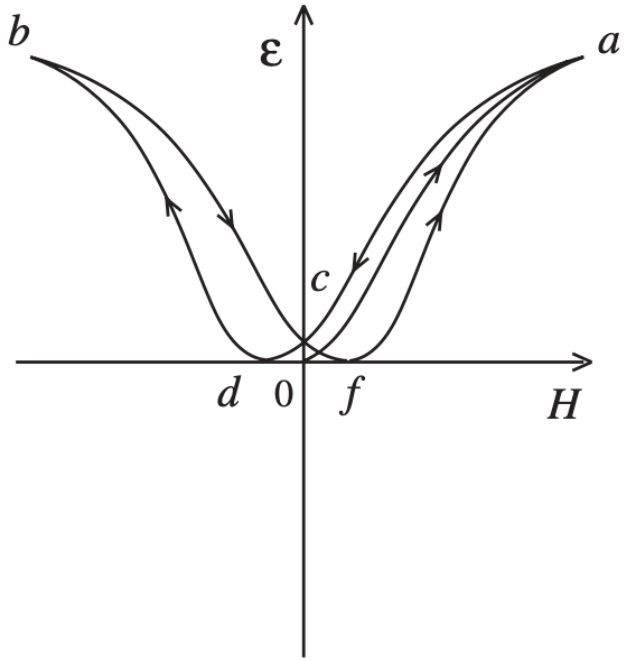


Magnetoestricção

Comportamento com campo magnético harmônico aplicado







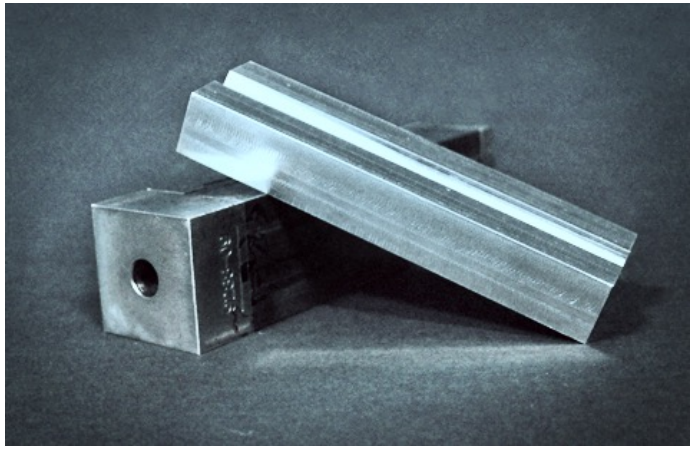
Materiais Magnetoestrictivos

Ferro

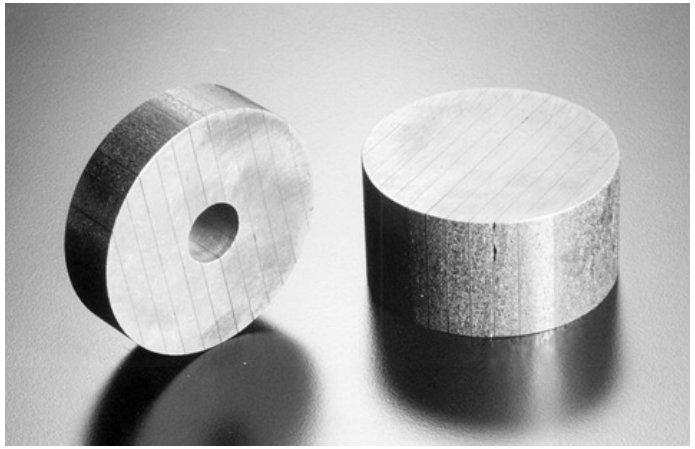
Nickel

Cobalto

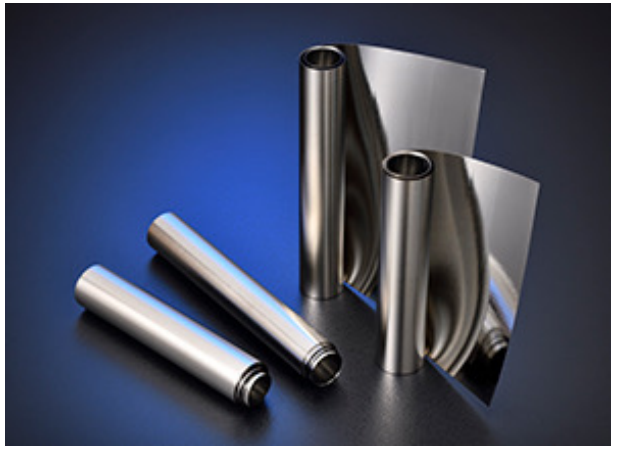
Galfenol (Ligas FeGa)



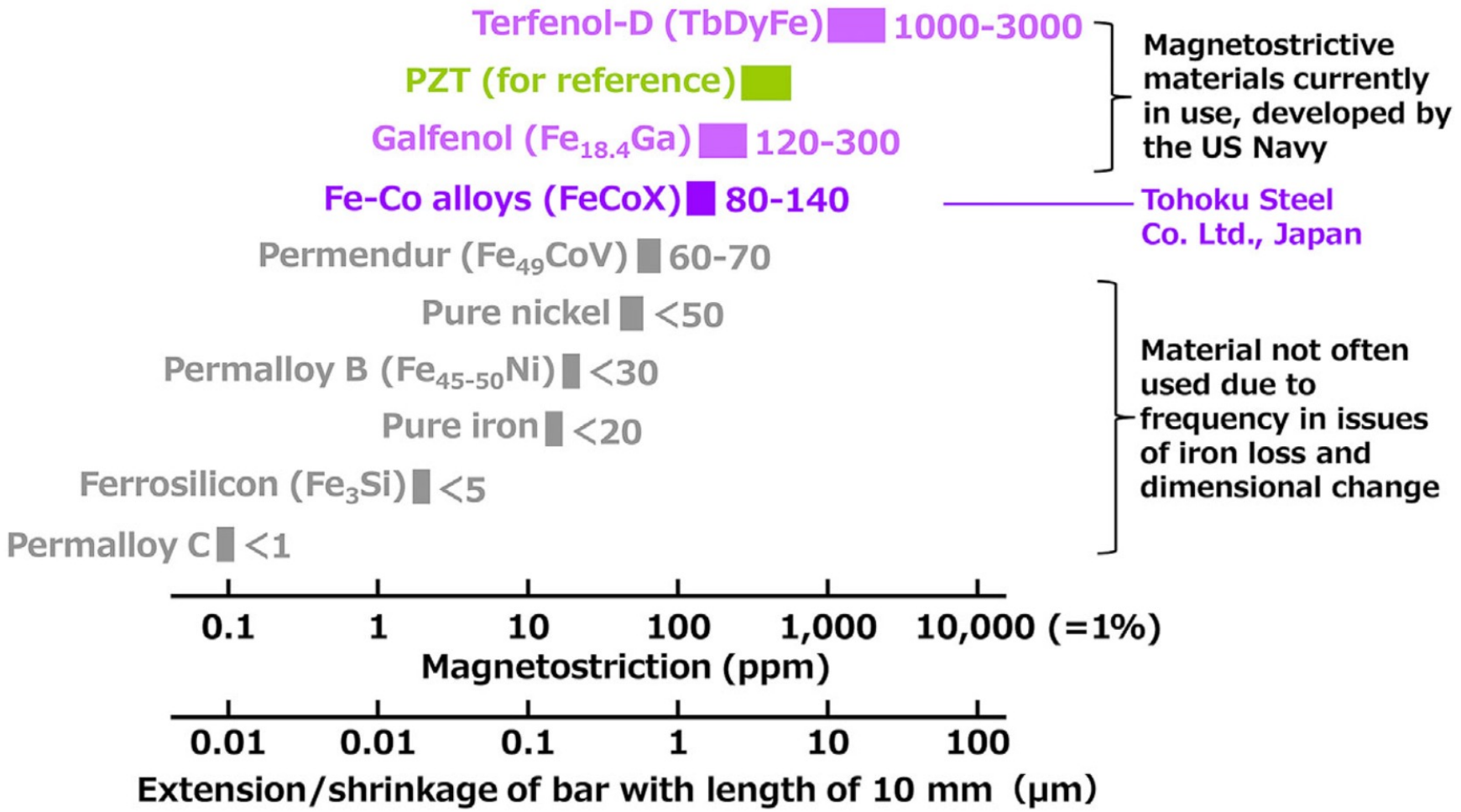
Terfenol-D



Metglas



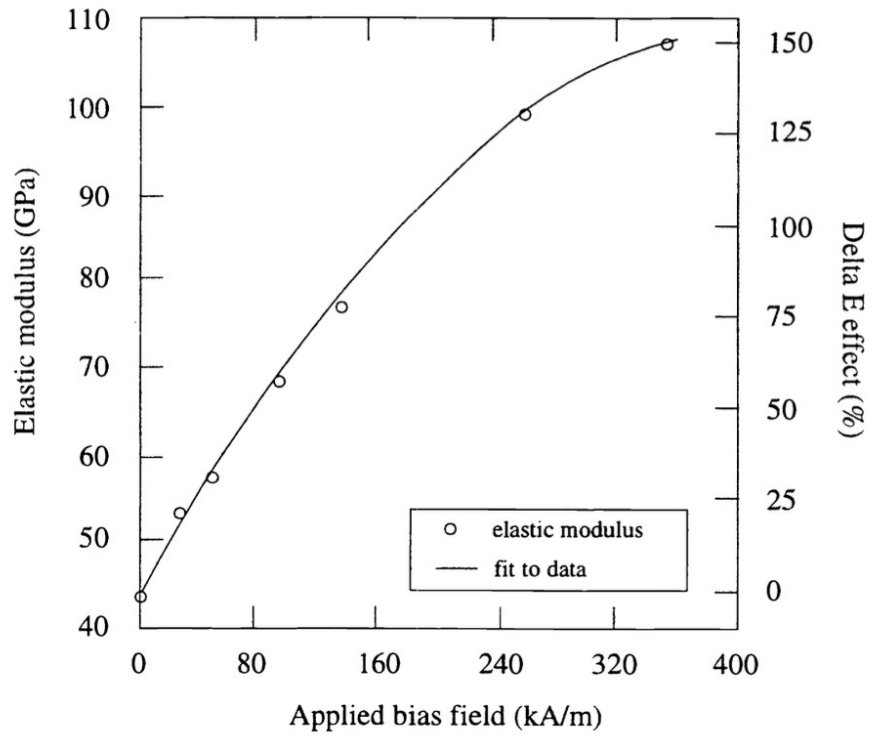
Materiais Magnetoestrictivos

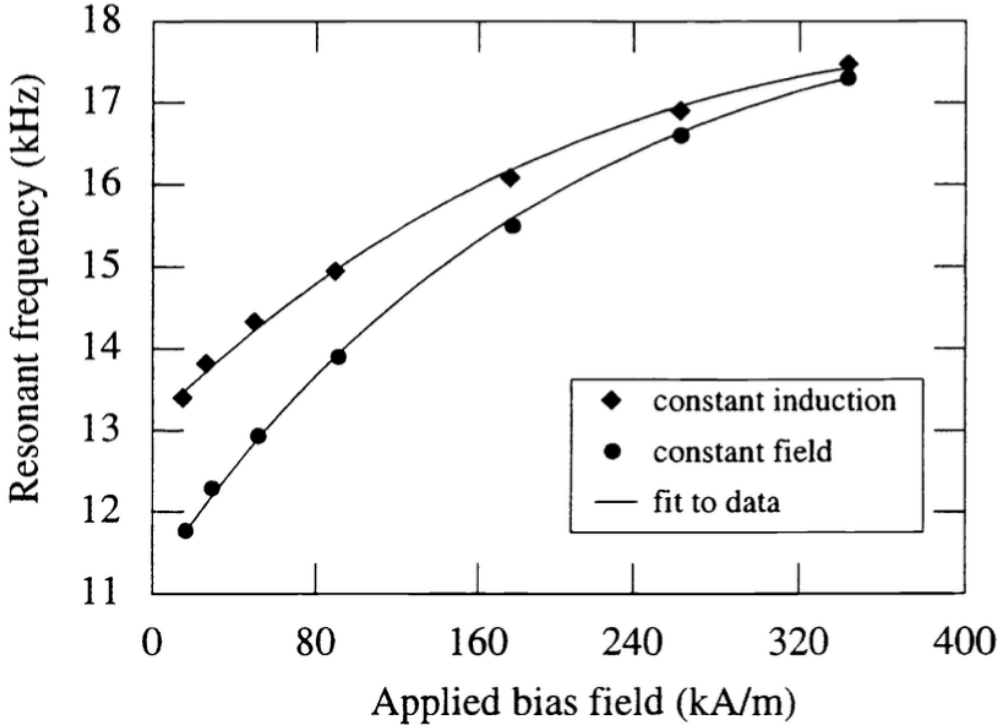


Magnetoestricção (Efeito ΔE)

Honda & Terada (1907) – On the Change of Elastic Constants of Ferromagnetic Substances by Magnetization

Terfenol-D

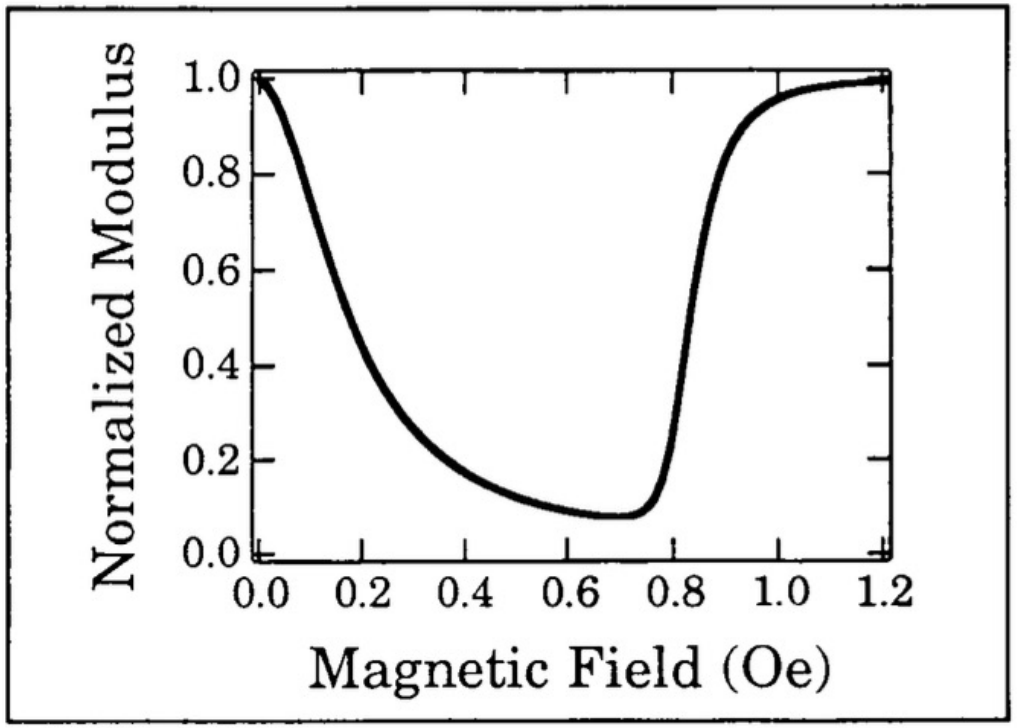




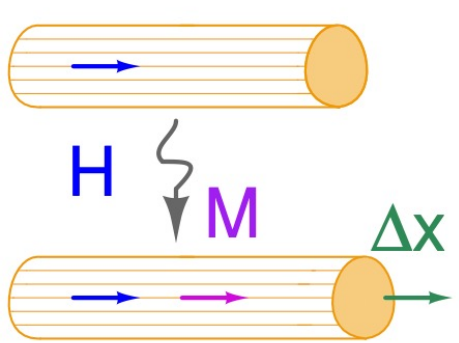
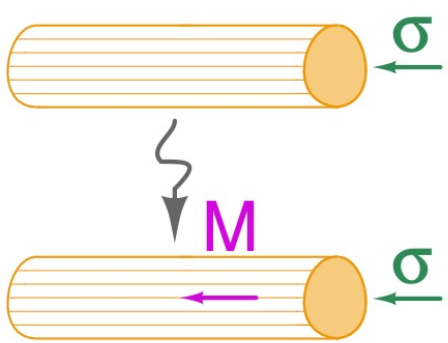
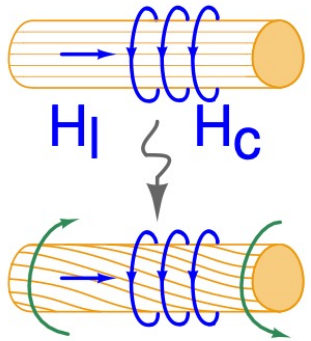
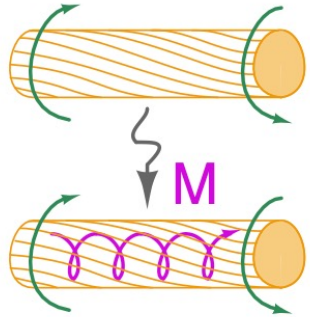
Magnetoestricção (Efeito ΔE)

Honda & Terada (1907) – On the Change of Elastic Constants of Ferromagnetic Substances by Magnetization

Metglas 2605 SC

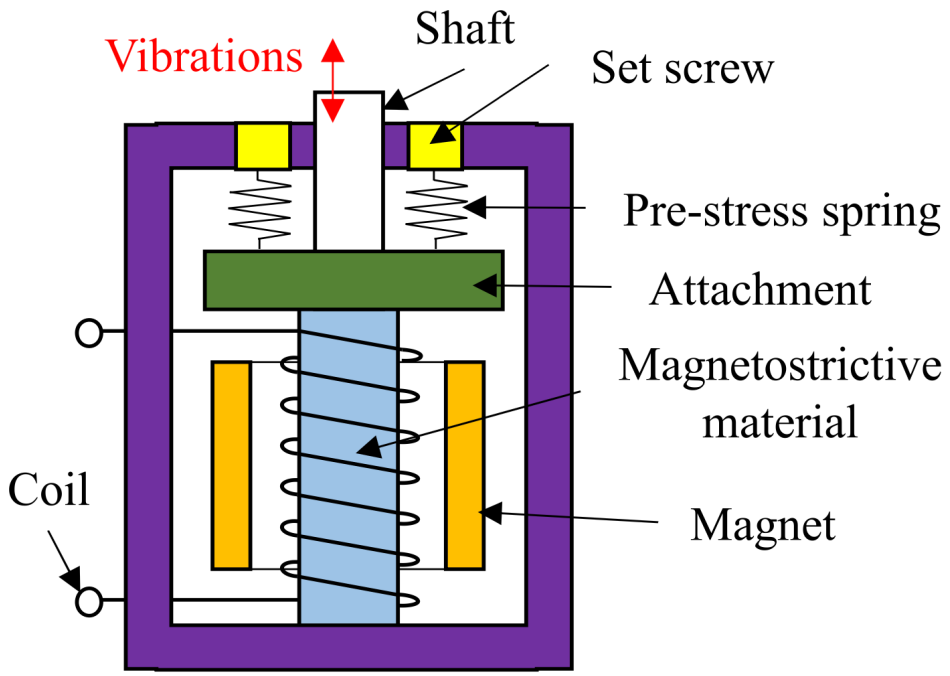


Magnetoestricção (Outros Efeitos)

Effect:	Joule (Direct)	Villari (Inverse)	Wiedemann	Matteucci
Application:	Actuation	Sensing/Harvesting	Actuation/Torque	Sensing
Sketch:				

Materiais Magnetoestrictivos - Atuadores

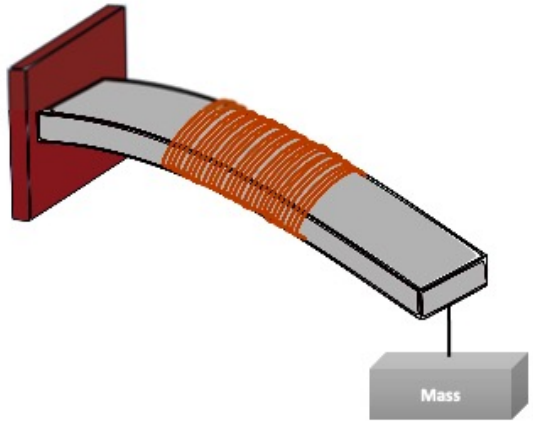
Linear



Moon et al. (2007)

Materiais Magnetoestrictivos - Atuadores

Cantilever



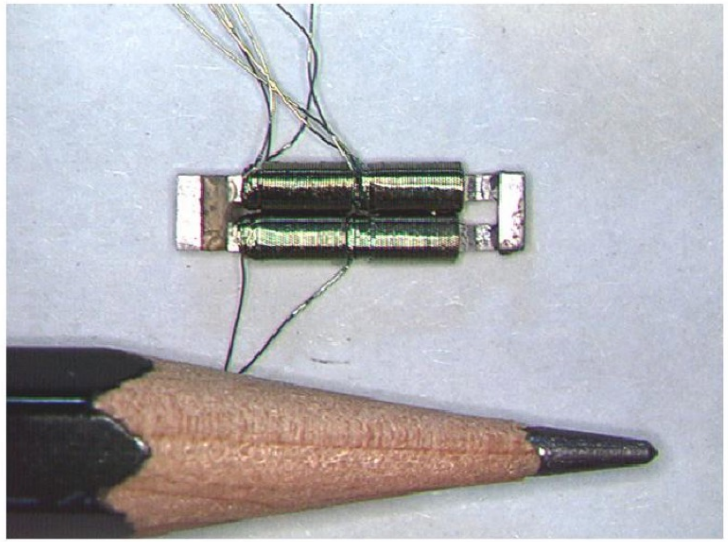
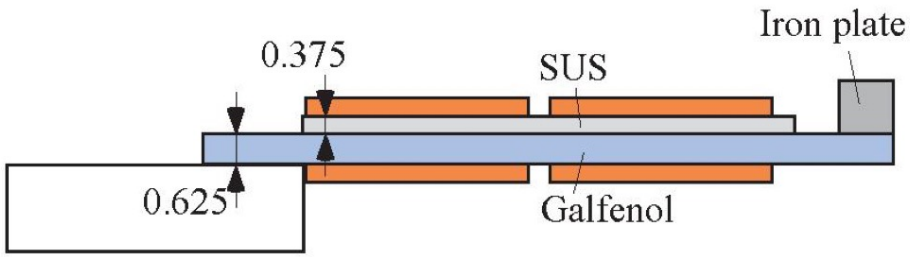


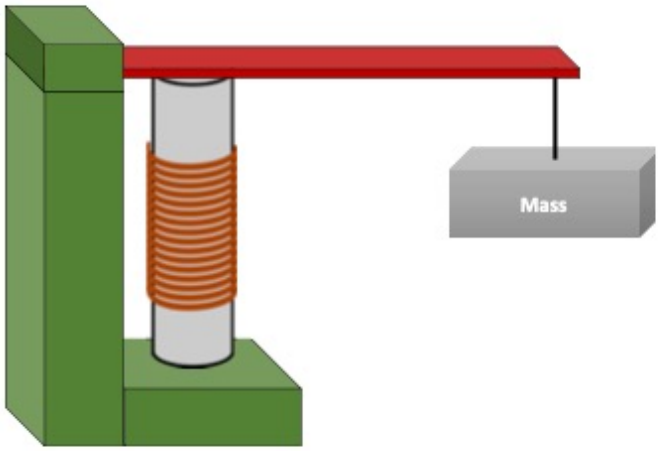
Fig.2. Fabricated actuator.

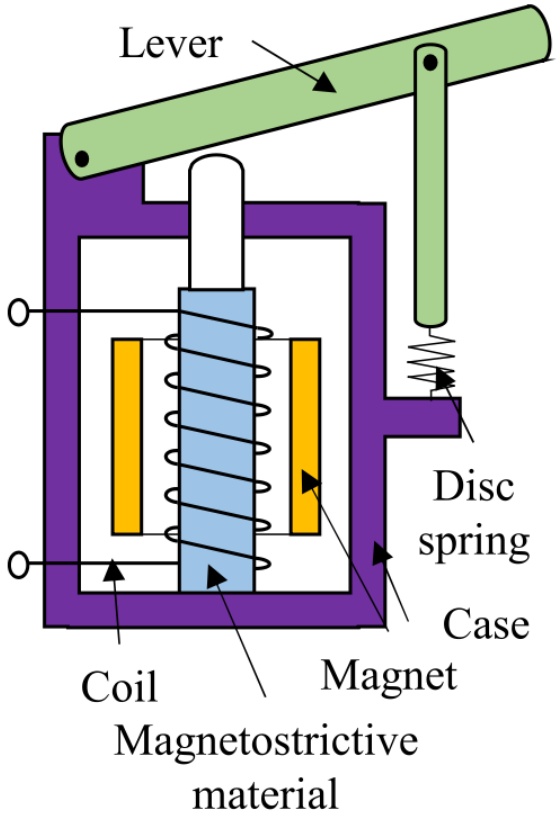


Ueno et al. (2008)

Materiais Magnetoestrictivos - Atuadores

Amplificadores



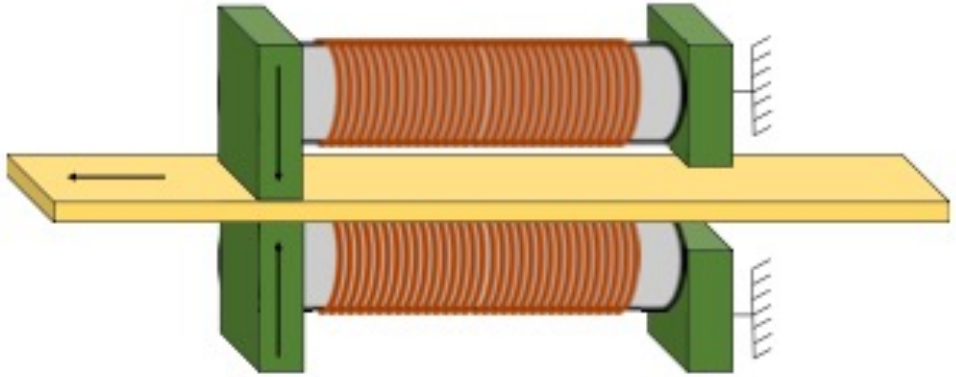


Barlet et al. (2019)

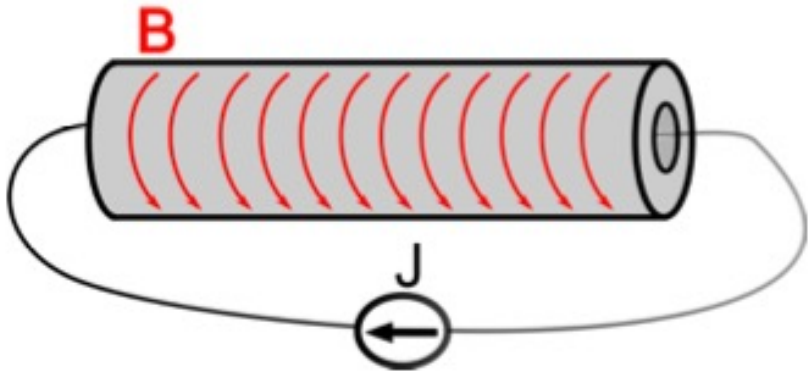
Cedrat Technologies (2019)

Materiais Magnetoestrictivos - Atuadores

Inchworm (Lagarta)

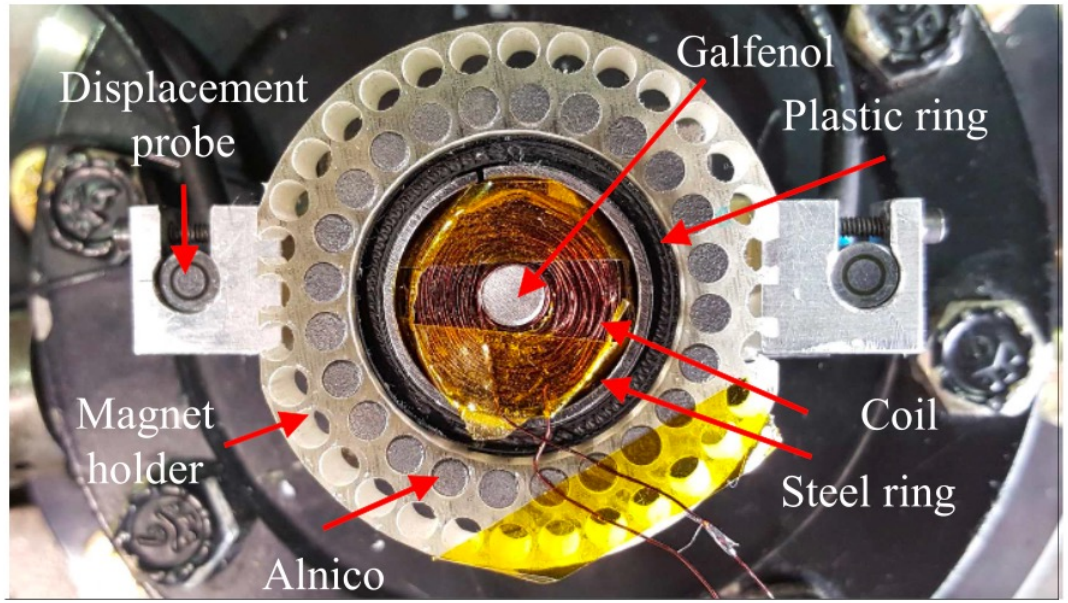


Outros

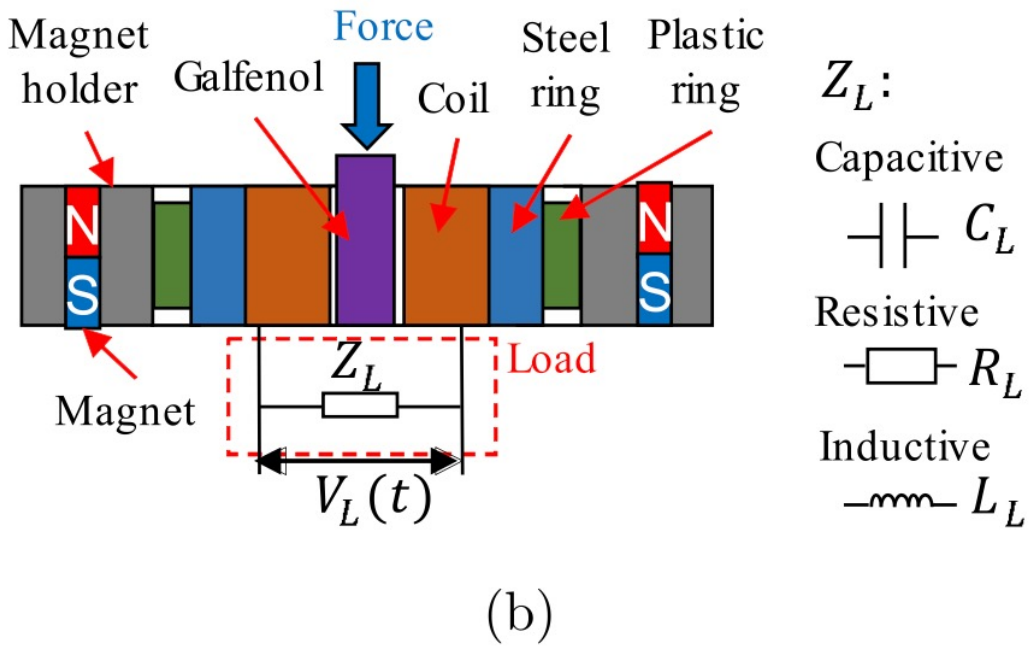


Apicella et al. (2019)

Materiais Magnetoestrictivos – Atuadores (Controle de Vibração)



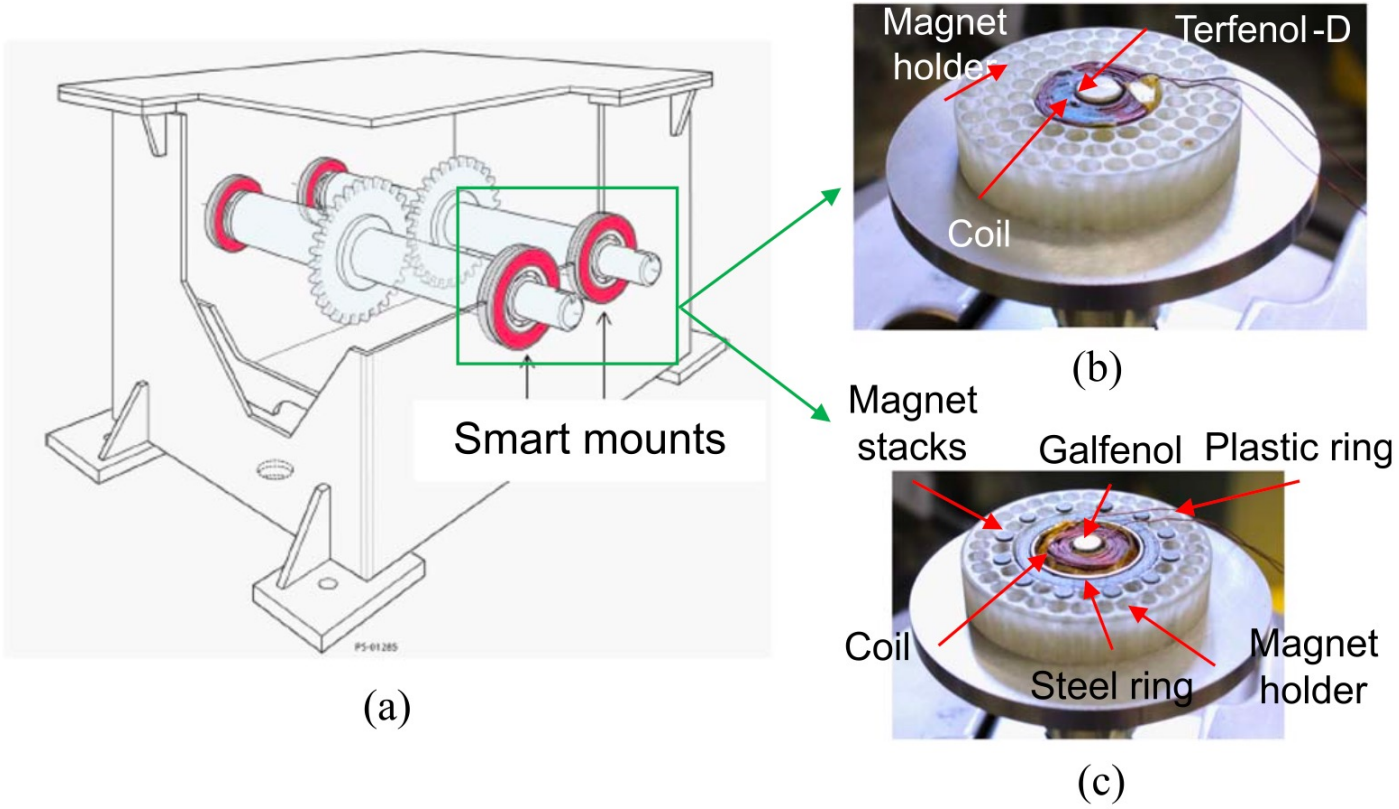
(a)



(b)

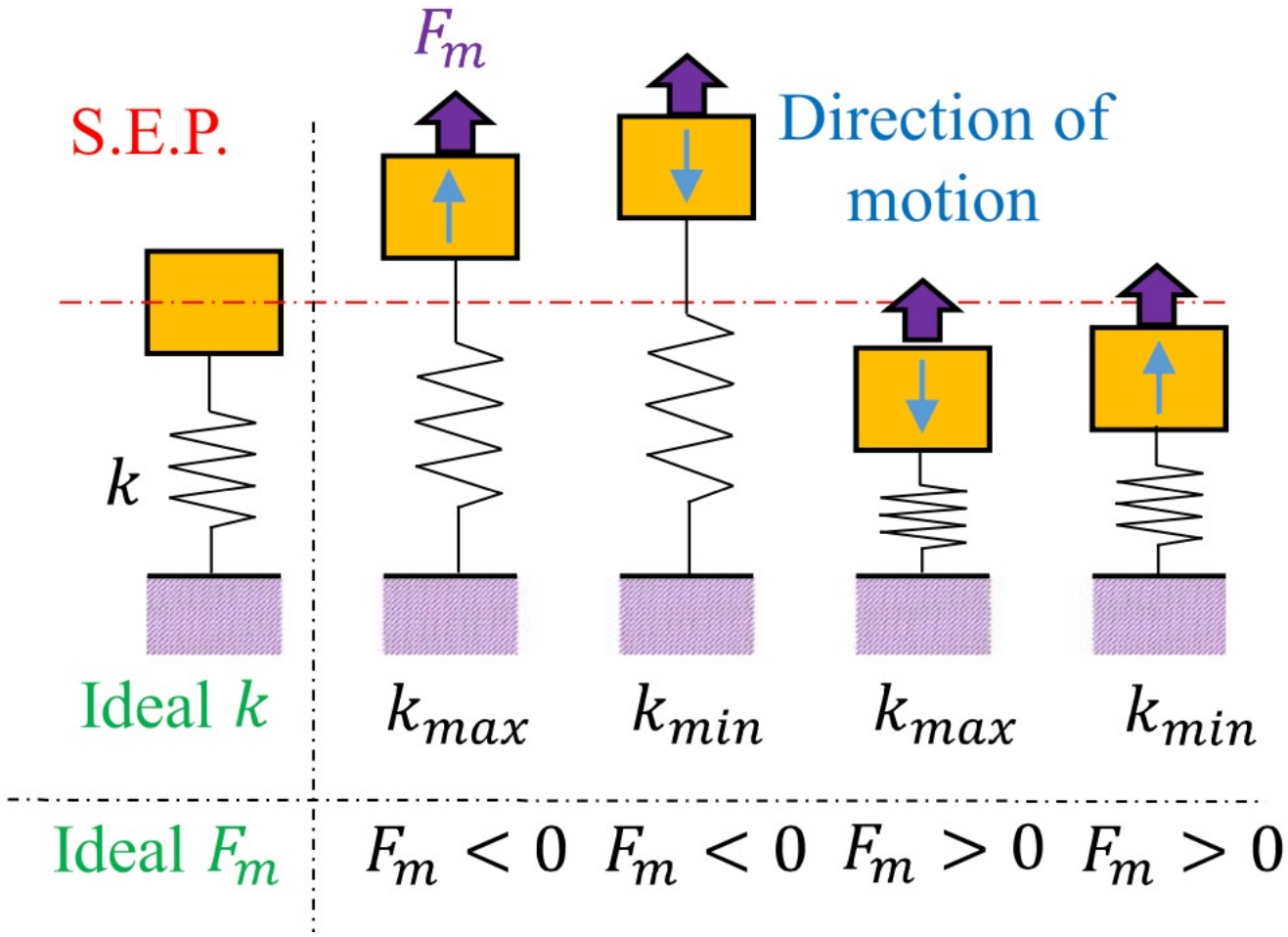
Deng et al. (2020)

Materiais Magnetoestrictivos – Atuadores (Controle de Vibração)



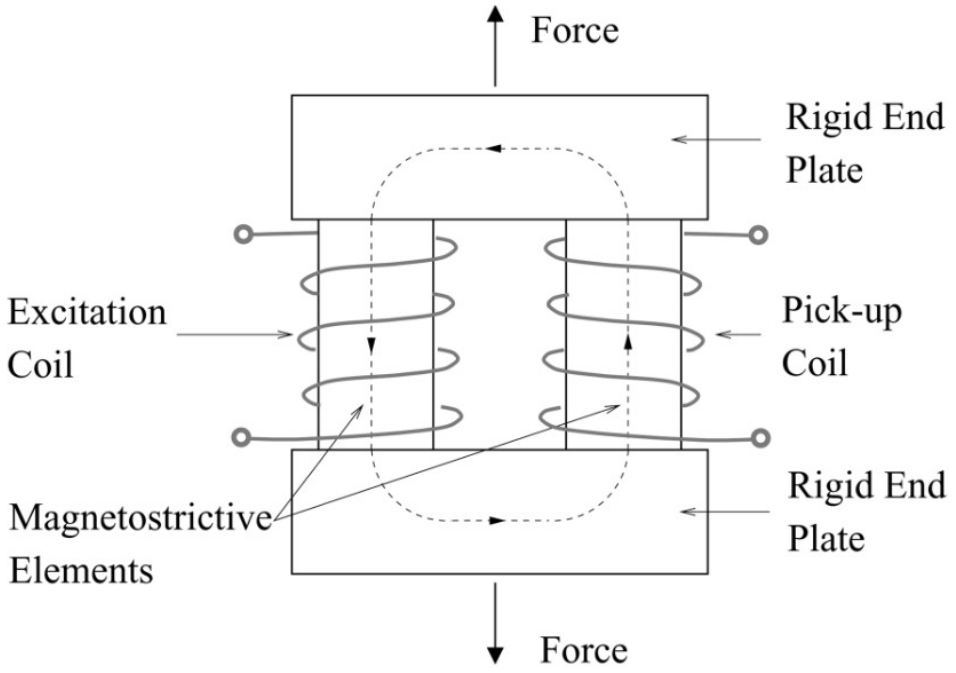
Deng et al. (2020)

Materiais Magnetoestrictivos – Atuadores (Controle de Vibração)

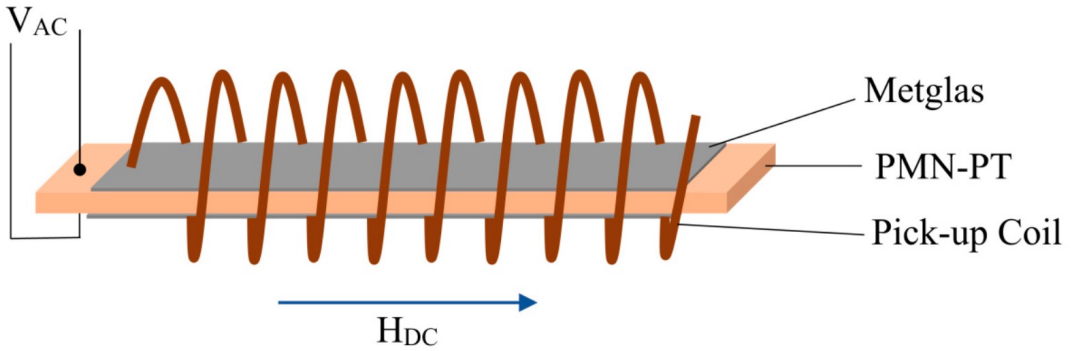


Scheidler et al. (2016)

Materiais Magnetoestrictivos – Sensores

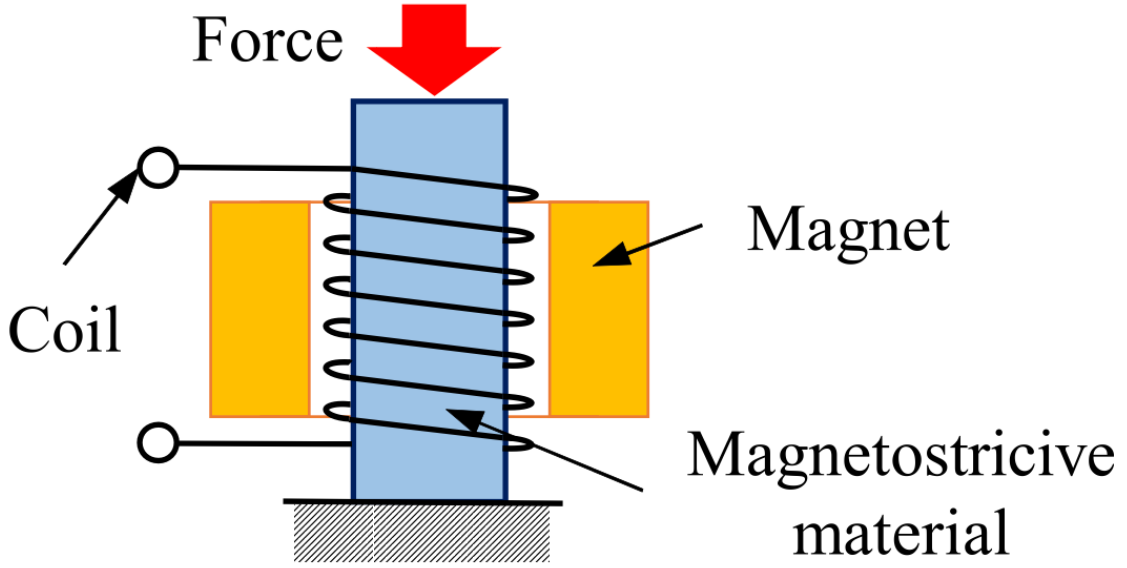


Dalpino (2004)



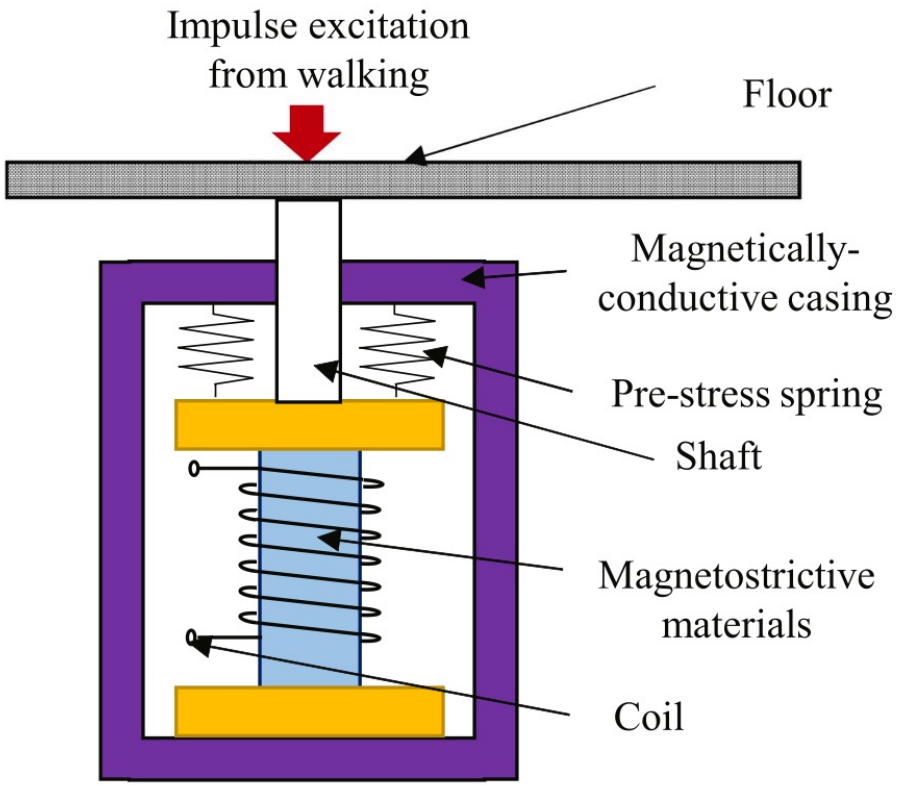
Bichurin et al. (2021)

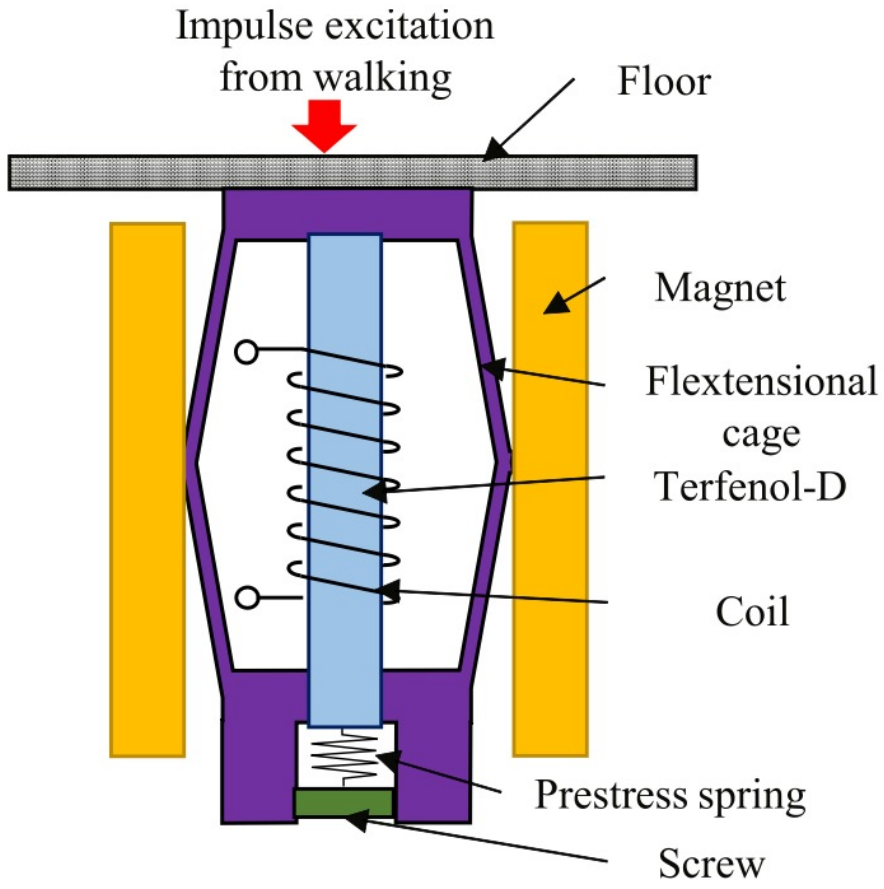
Materiais Magnetoestrictivos – Colheita de Energia



Materiais Magnetoestrictivos – Colheita de Energia

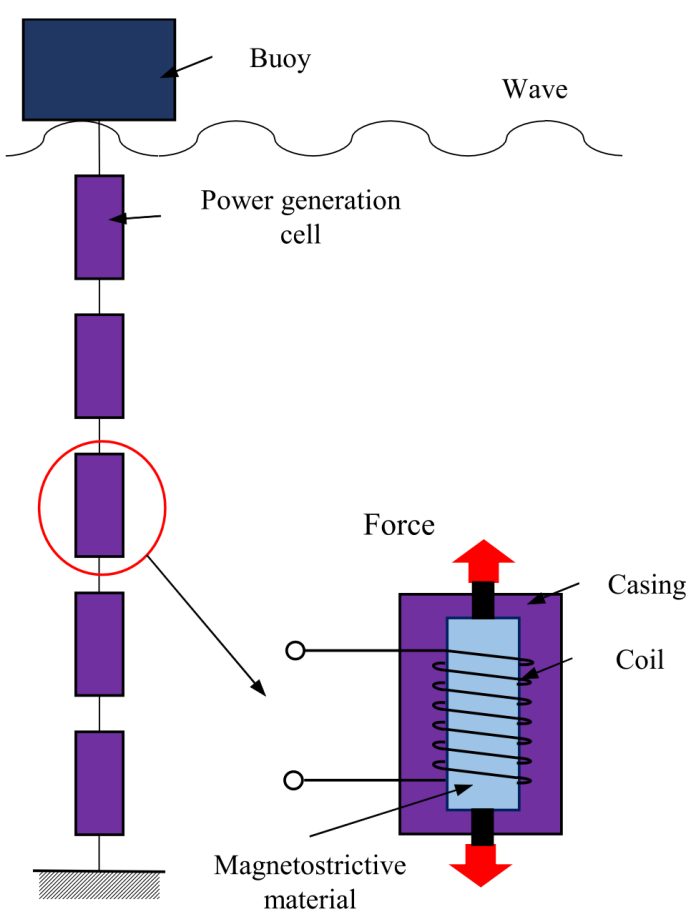
Tipo Axial

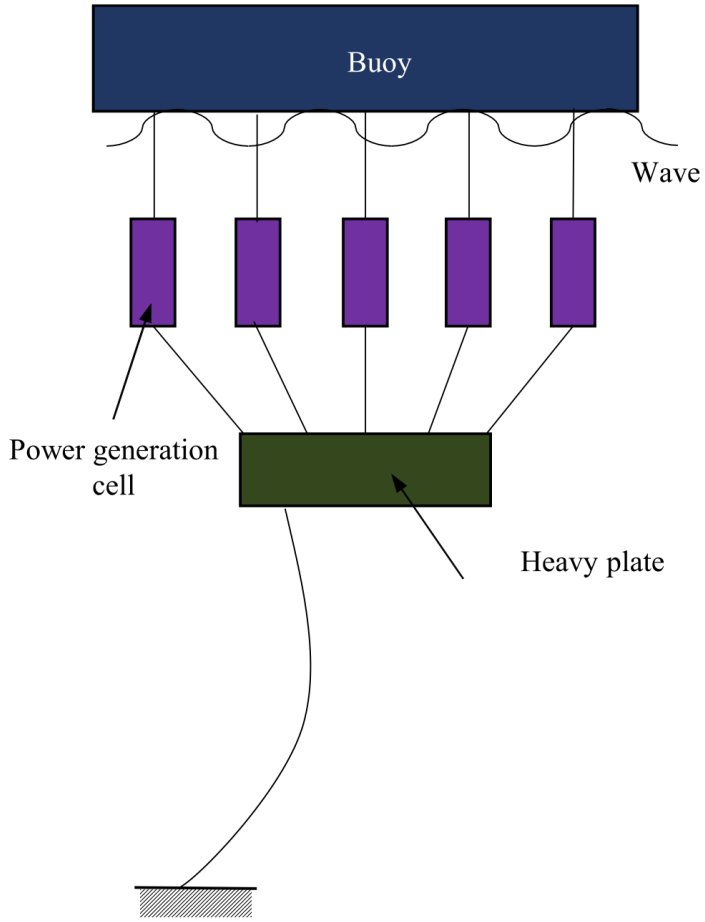




Materiais Magnetoestrictivos – Colheita de Energia

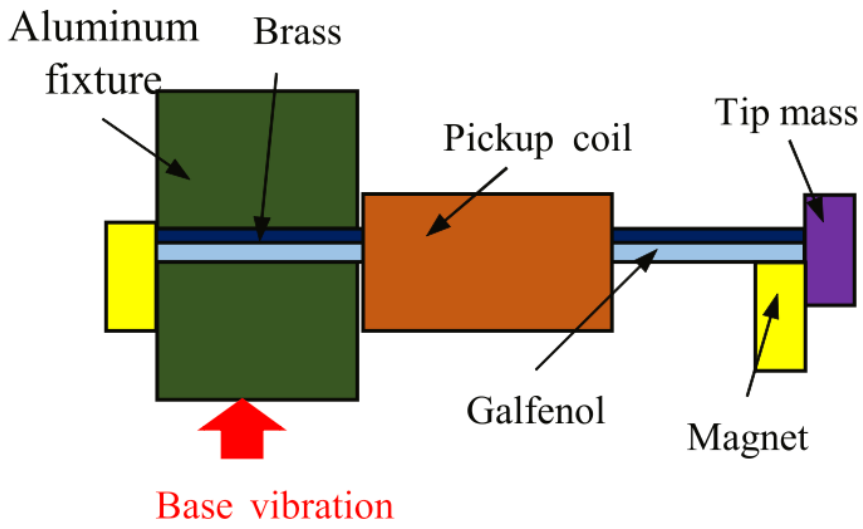
Tipo Axial

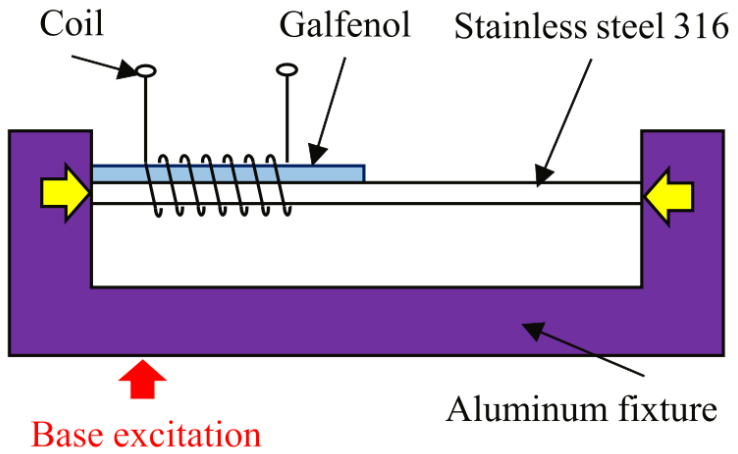


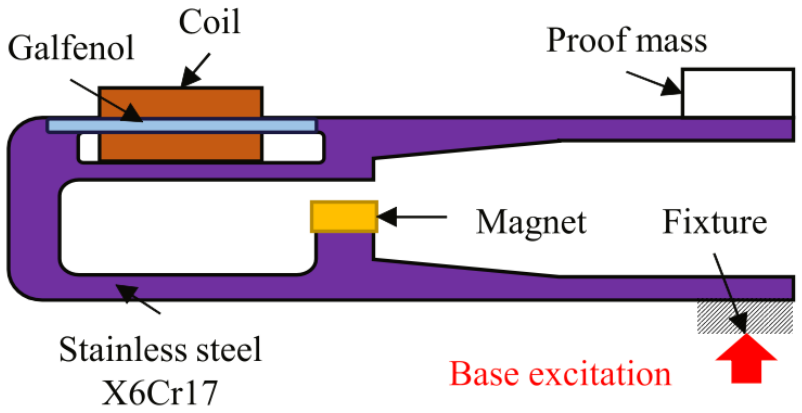


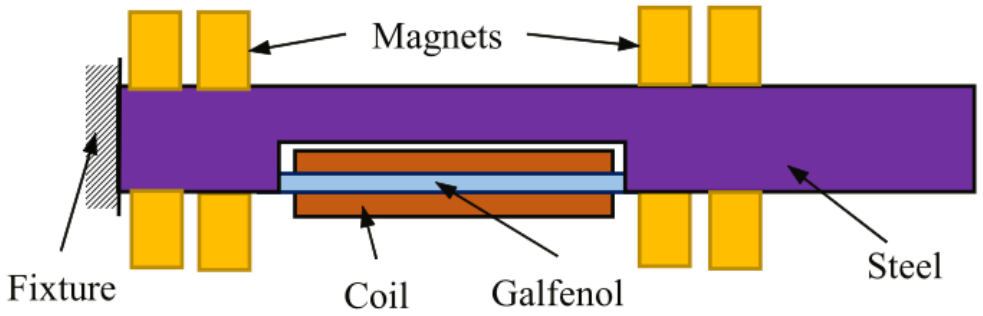
Materiais Magnetoestrictivos – Colheita de Energia

Tipo Flexural



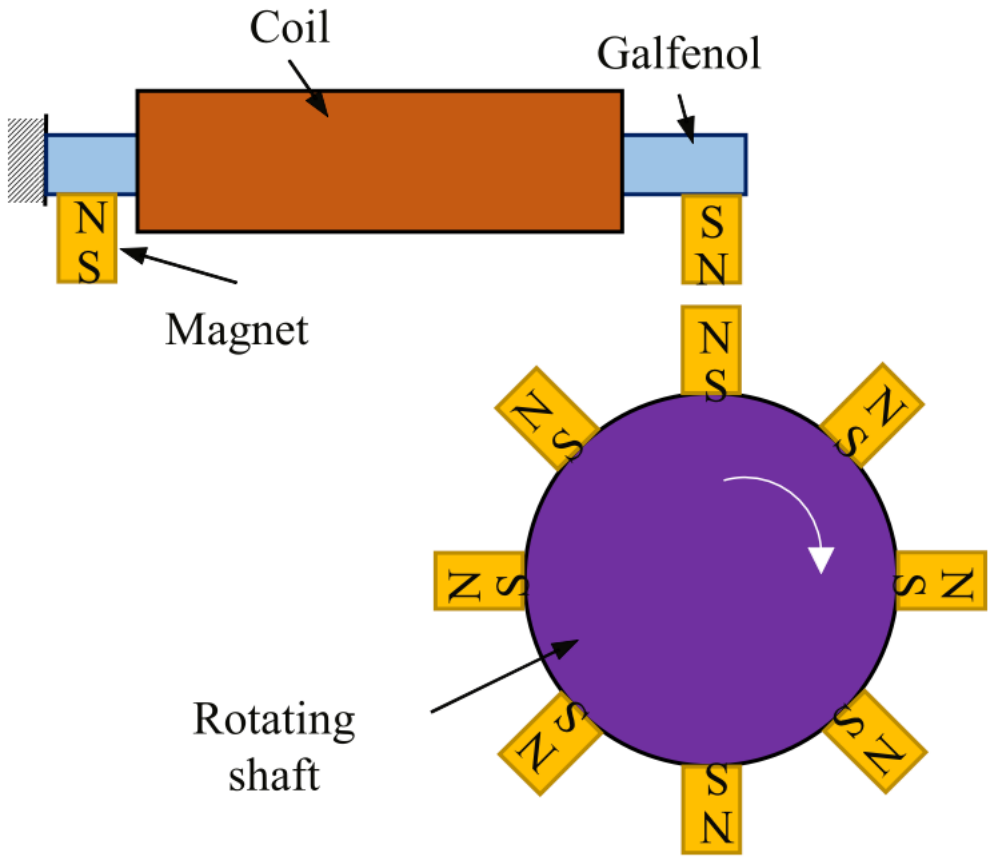






Materiais Magnetoestrictivos – Colheita de Energia

Tipo Rotacional



Materiais Magnetoestrictivos – Colheita de Energia