From magnetorheological elastomers towards functionalized structures

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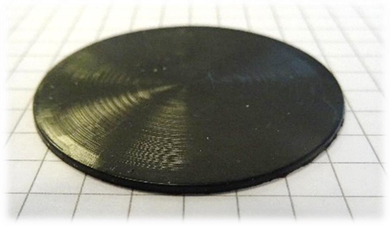
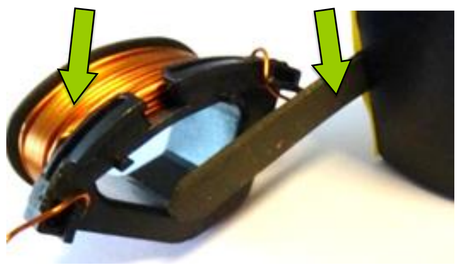
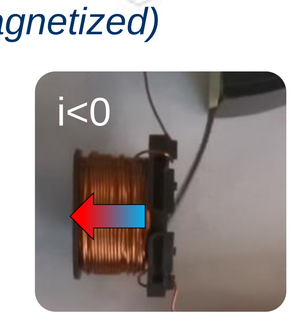
Introduction

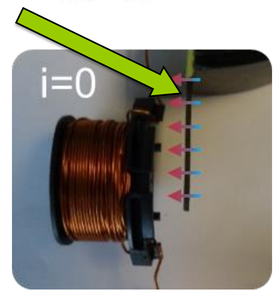


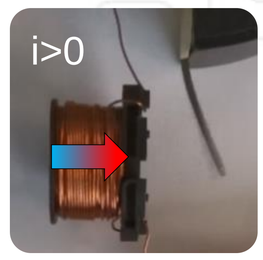
Composite material consisting of silicone and NdFeB particles

coil *composite (magnetized)*









Dynamic actuation by electromechanical field possible

Mechanical characteristics

- **E*** : dynamic modulus also described as $E^* = E' \cdot (1 + \boldsymbol{i} \cdot \tan(\delta))$
- **E'** : storage modulus
- $\boldsymbol{\tan(\delta)}$: loss factor

strain ε_{mag}

magneto-mechanical behavior

strain ε_{mech}

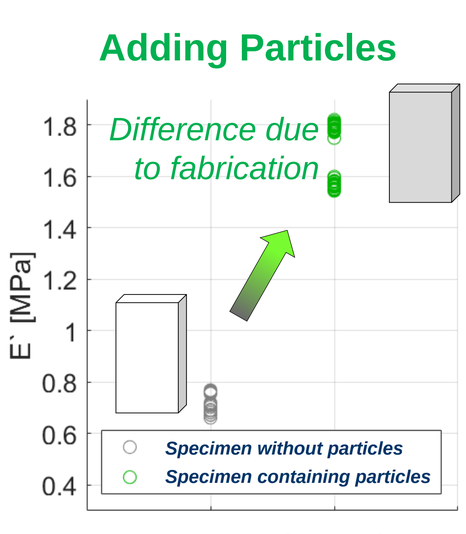
Magnetic characteristics

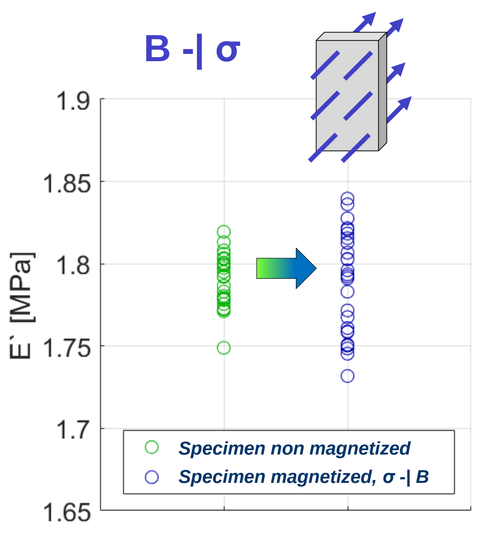
- **M** : magnetization
- $\boldsymbol{\mu_r}$: relative permeability
- $\mathbf{H_c}$: coercitivity

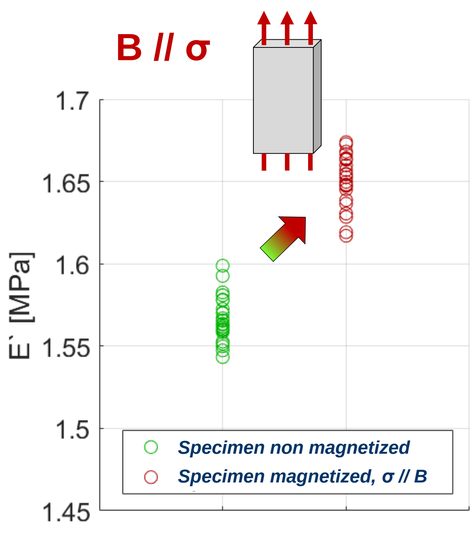
Experimental investigation

Dynamic Mechanical Analysis

- Measurement of dynamic **mechanical characteristics**
- Tensile, compressive and shear tests possible
- Dynamic loading under controlled frequency and temperature conditions

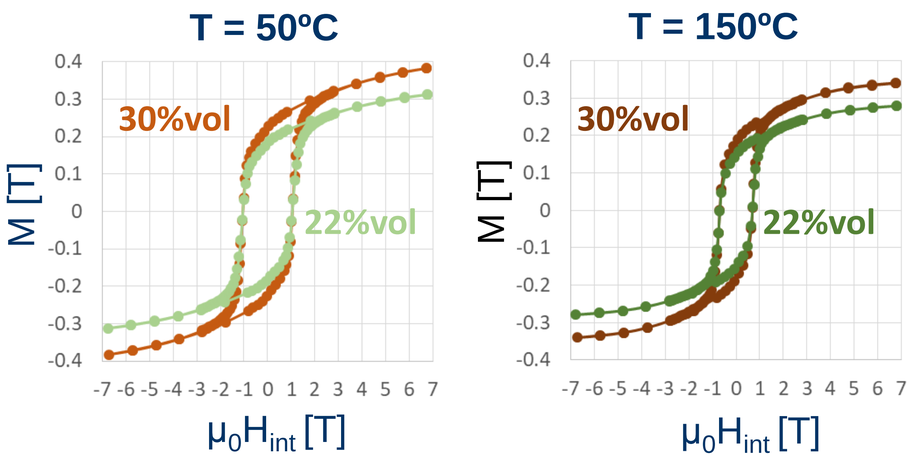






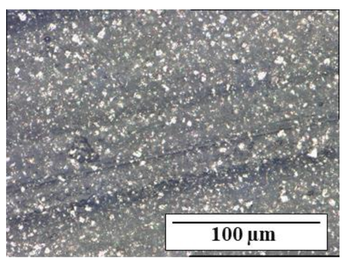
Tests conducted at ambient temperature, solicitation frequency f = 0.017Hz

- Measurement of **magnetic characteristics** by using an extraction type magnetometer
- Control of external magnetic field H_a and temperature T
- Calculation of internal field H_{int}



➢ Volume fraction of NdFeB in silicone and temperature have an influence on the magnetic characteristics

Lack of knowledge

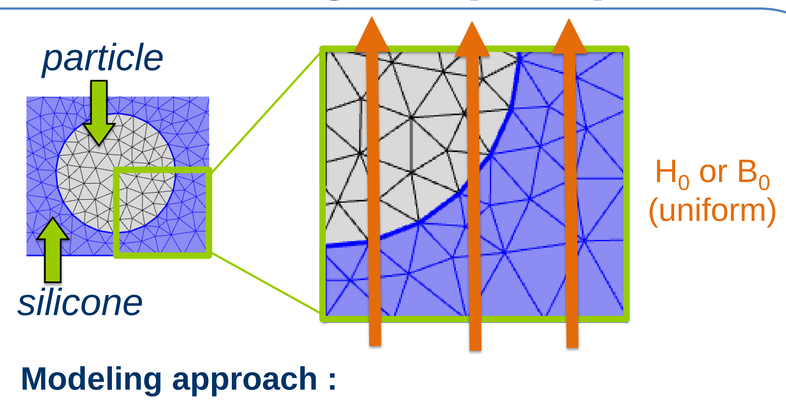


Microscopic image of the composite's surface, Keyence

- Structural aspects (form and dispersion of particles, influence of magnetization process)
- Magneto-mechanical properties and suitable characterization method of coupled characteristics

Industrial needs & methodological perspectives

- Fabrication of an innovative hyperelastic magnetic composite material
- Experimental magneto-mechanical characterization method
- Modelization of material's behavior



Modeling approach :

Application of uniform magnetic field to composite

Utilization of magnetic characteristics B(H) to find ε_{mag}

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