



**Pablo GRIFFITHS**

PhD (Institut Carnot I@L), 2019 – 2022  
MATEIS (Sylvain MEILLE, Guilhem BAEZA)  
LGEF (Gildas COATIVY)

# Induction stimulated healing of rubber-like materials

## Context



### Current self-healing materials

Limited by their mechanical properties

### Objective

Localized heating/melting of a material exhibiting suitable mechanical properties

### Thermoplastic elastomers (TPE)

Hard Segments HS  / Soft Segments SS   
Easily shaped (thermo-reversible and elastic properties)

### Magnetic particles (MPs)

Heating induced by hysteresis loss, eddy currents, Néel or Brown relaxation  
Enhancement of mechanical properties



TPE/MP composites

## Method and tools

### Particle representation

X-Ray Diffraction (magnetic particles varying in size and nature)

### Surface imaging

Atomic Force Microscopy (contrast HS/SS)  
Scanning Electron Microscopy (contrast particles/polymer)

### Thermo-mechanical characterization

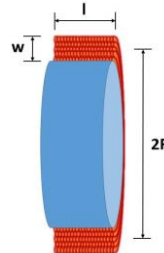
Rheology (DSS, DTR tests)  
DSC (glass transition, melting, crystallization)

### Magnetic/ dielectric characterization

Winded samples subjected to a magnetic field  
Dielectric spectroscopy

### Thermo-magnetic tests

Magnetic inductor  
Induction generator & IR camera

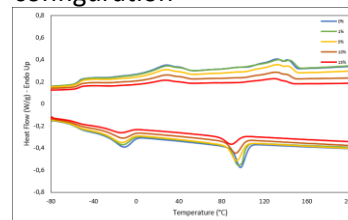


Winded sample for magnetic tests

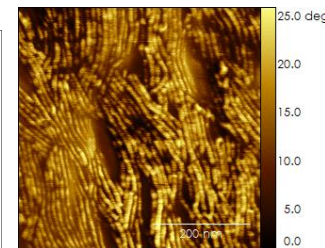
## Results

**(AFM)** Hard segments linked and structured in a favored direction

**(DSC)** Matching behavior in heating/cooling, meaning that the presence of MP fillers do not alter the HS/SS configuration



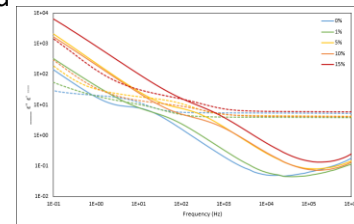
DSC of TPU/Iron MPs



TPU (500 nm x 500 nm)

**(MEB/AFM)** Well-dispersed MPs in extruded and hot-pressed composites  
**(Dielectric & Magnetic)**

Enhanced conductivity and relative permeability with filler fraction



Dielectric spectroscopy of iron MPs