

 	<p><b>INTERNSHIP</b></p> <p><b>Impact of surface laser treatments on the magneto-mechanical properties of GOES with different magnetic states at the macroscopic and microscopic scale</b></p> <p>E. SALLOUM / O. MALOBERTI</p>	<p><i>Master M2</i></p>
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**KEYWORDS :** Soft magnetic materials, GOES (Grain Oriented Electrical Steels), Laser irradiation, scribing, ablation, magneto-mechanical behaviour, magnétostriction, Single Sheet Tester, magnetic structures, domains, MOIF (Magneto-Optical Indicator Film), MFM (Magnetic Force Microscopy),

**CONTEXT :** <https://www.essial.eu/fr>

Part of the investigations carried out during the beginning of the ESSIAL project shows that it is possible to significantly damp the magnetic induced strain, ie the equivalent apparent magnetostriction in the rolling direction, inside GOES thanks to specific surface laser treatments (irradiation, scribing, ablation). Static and dynamic magneto-mechanical properties have been modeled, linked to the magnetic structure sensitive behaviour, and then identified. These first macroscopic analysis deduced an important role played by the volume fraction, type, size and polarization direction of distinct domains misoriented from the main domains oriented in the rolling direction. However, we still do not know in details the type, size and polarization direction of these domains as a function of the laser process parameters. MOIF and MFM probes can be used to observe in details the magnetic structure with still uncertainties concerning the polarization direction in each domains. Performing the magnetic imaging under a controlled magnetic field is one of the solution to distinguish the different types of domains' orientations.

### **GOALS :**

The main goals of this internship is to contribute to the understanding of the physical reasons why surface laser treatments have various impacts onto the magneto-mechanical properties through the change in the magnetic structure.

There are two ways to address these questions:

- 1) The first one is to correlate the laser process parameters to the magneto-mechanical properties identified at the macroscopic scale. This way requires to use both an experimental single sheet tester and a mesoscopic model to identify the change in magneto-mechanical properties.
- 2) The second one is to characterize in details the magnetic domains at the vicinity of laser impacts onto the surface at the microscopic scale

Therefore, it will be proposed to the candidate to:

- 1) Carry out macroscopic magnetic and vibration measurements following the experimental plans and the identification method specified by PhD students with the aim to correlate the laser process parameters and the magneto-mechanical properties.
- 2) Contribute to the design and definition of a unique fields source compatible with the two imaging techniques and apparatuses used in the lab (MOIF and MOKE). This last source will provide a solution to analyze and distinguish more details within a magnetic structure. The aim is to be able to visualize and identify the magnetic domains size, types and polarization directions as a function of a laser treatment.

Results expected are a complete report presenting the magneto-mechanical properties identified as a function of laser process parameters and the complete definition of a Fields source compatible with the MOIF and the MFM imaging techniques.

### **MISSIONS :**

- o Bibliography
  - Soft magnetic materials and its magnetic structure with domains and walls
  - Magneto-mechanical measurements with the SST (Single Sheet Tester)
  - Microscopic observation and imaging techniques of magnetic domains
- o Carry out experimental measurements of the magneto-mechanical behaviour following the experimental plan and laser parameters proposed by the PhD students and post-docs.
- o Save and analyze the experimental data to identify the magneto-mechanical properties
- o Initiate a correlation between magneto-mechanical properties and laser parameters
- o Design the fields source adapted to the MOIF camera and the MFM sample holder
- o Specify the fields source (mechanical parts, core, yoke, coils, electrical source ...)
- o Valorization:
  - Report: experimental data, properties identification
  - Whole files Complete definition and specifications

### **EQUIPMENT / MATERIALS / SOFTWARE**

- o GOES samples
- o Software :
  - MATLAB-SIMULINK (data sorting and identification algorithm)
  - COMSOL or FLUX (CAO in electromagnetics)
- o Models : mechanical, magnetic and magneto-mechanical mode
- o Single Sheet Tester (SST)
- o MOIF CMOS-Magview camera
- o MFM

### **PARTNERSHIP :**

ESIEE, UPJV, MULTITEL (laser treatments), IRT-M2P (thermal treatments)

**EDUCATION :**

Material engineering, Mechanical engineering, Electrical Engineering, English

**DURATION :** 6 months

**GRATIFICATION :** to be negotiated

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