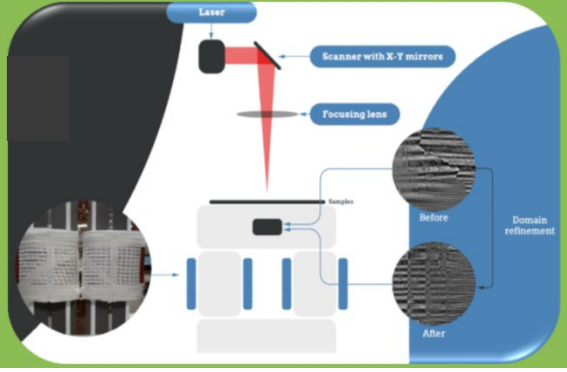
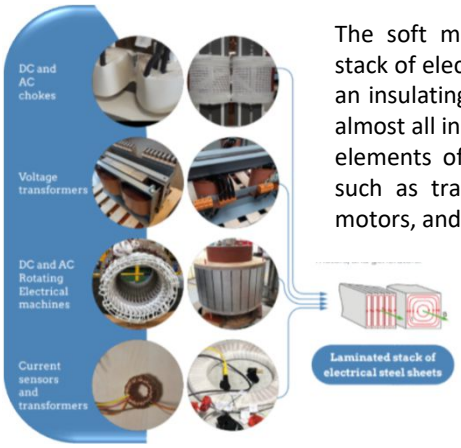
PROCESS FOR MANUFACTURING AN ELECTRICAL STEEL



CONTEXT



The soft magnetic materials, made from stack of electrical steel sheets separated by an insulating layer, are becoming crucial in almost all industrial sectors, as they are key elements of industrial electrical machines such as transformers, sensors, actuators, motors, and generators.

Standard processes used to refine the magnetic structure of such materials and reduce the iron losses are based on mechanical scratching hard to upscale and continuous lasers without thermal resilience.

INNOVATION

A new magnetic domains refinement technique based on the Ultra-Short-Pulsed-Lasers (USPL) is proposed with both upscaling capabilities and thermal retention properties in addition to tailoring flexibility and better performances for the iron losses and the reactive power as well at various working conditions (see table below).

OUTCOMES

Energy and power savings : This process makes it possible to decrease both the iron losses and the reactive power needed due to magnetic reversal mechanisms up to 20% and even more for a large range of working conditions

Control of vibrations and magnetic noise : decrease of both the magnetic induced vibrations and noise up to 50% (-3 dB).

Reduction of global cost : Energy saving during the whole life cycle leads to a significant reduction of global cost up to 20%.

Thermal retention properties : The USPL technique provides thermal retention capabilities not achievable by the standard surface laser treatment in the industry (CW and LPL, see table).

Tailor made process Usable and useful before thermal annealing or/and coating : The laser parameters and patterns can be adjusted for each alloy and grade and adapted to the flux working condition.

high quality mass production capabilities : The process provides thin, deep and clean grooves and is compatible with mass production thanks to the high repetition frequency of pulses.

LASER	Max. loss reduction (%) Thickness = 0,23/0,27 mm			Max. permeability increase (%) 0,23 / 0,27 mm			Max. vibration reduction (dB) 0,23 / 0,27 mm		coating	Thermal retention (°C)	Coating retention	Max. speed (mm/s)
	i	m	s	l	m	s	i	m				
I	-20/-20	-10/-5	-20/-15	+20/+15	+10/+10	-3/-2	-10/-15	-3/-3	*a priori*	450	No	NA or 5
S	-40/-20	-10/-5	-20/-15	+30/+25	0	-4/-3	-15/-15	-6/-6	*a posteriori*	550	No	125
A	-50/-35	-25/-20	-20/-15	+40/+35	-10/-20	-5/-4	-20/-20	-6/-6	*a posteriori*	>750	yes	>125

I: CW/LPL Long Pulsed Laser Irradiation
S: SPL Short Pulsed Laser Scribing
A: USPL Ultra-Short Pulsed Laser Ablation

Losses: (i) 0,1T / (m) 1T-50Hz / (s) 1,7T-50Hz
Permeability: (i) 0,1T / (m) 1T-50Hz / (s) 800 A/m-50Hz
Vibrations: (i) 0,25T / (m) 1T

APPLICATIONS

Magnetic Components: choke inductors, current and voltage transformers / Electrical Machines: motors and generators / Metallurgy of Electrical Steels, Ferromagnetic Alloys / Surface Laser Treatments

MARKET

The market of electrical steels shows a growth of 8% per year in the world.

INTELLECTUAL PROPERTIES

European patent EP22212542.9

TRL : 5/6

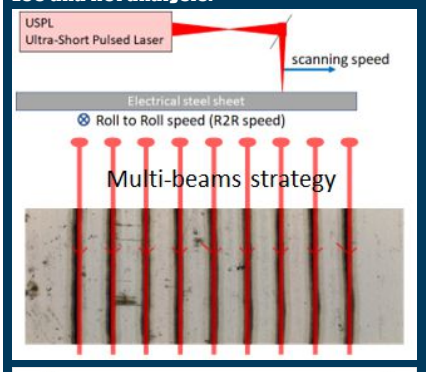
PARTERNSHIP 1:

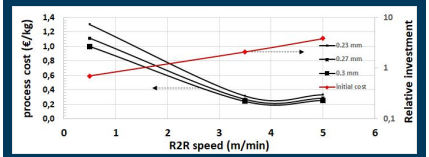
End-users manufacturing magnetic products interested in upgrading their electrical machines, magnetic circuits and components.

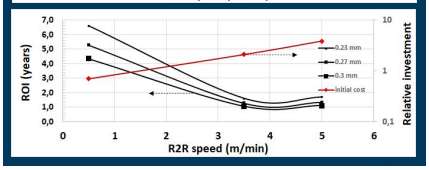
PARTERNSHIP 2:

Metallurgists manufacturing Roll to Roll coils interested in upgrading their electrical steels and sheets.

LCC and ROI analysis:







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