SMM25
25th Soft Magnetic Materials Conference
2-5 May 2022, Grenoble, France

Relative control of domains structure and phases in electrical steels by laser process parameters and patterns

O. Maloberti[1,2], M. Nesser[1], T. Etifier[1,2], J. Dupuy[3], P. Dassonvalle[1,4], C. Pineau[5], S. Panier[2], J. Fortin[1,2], J-P. Birat[6]

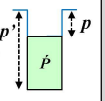
[1]*SYMADE-UNILASALLE Amiens, 14 quai de la Somme, 80080 Amiens, France;* [2]*LTI Laboratory, IUT d'Amiens, Avenue des Facultés - Le Bailly 80 025 Amiens, France;* [3]*MULTITEL, 2 rue Pierre et Marie Curie, 7000 Mons, Belgique;* [4]*MIS Laboratory, UPJV, 14 quai de la Somme, 80080 Amiens, France;* [5]*IRT-M2P, 4 rue Augustin Fresnel, 57070 Metz;* [6]*IF-steelman, 5 rue du gate chaux, 57280 Semecourt, France.*

Introduction: This work investigates the impact of surface **U**ltra-**S**hort-**P**ulsed-**L**aser ablation process (USPL); mainly the **groove depth** (***p***), **L**aser **I**nduced **S**hock **W**ave (LISW) **pressure** (***Ṕ***) and **line spacing** (***d***); on magnetic characteristics of **G**rain-**O**riented **E**lectrical **S**teels (GOES) by using an average dynamic μ-v_c-Λ model [1] and the **T**ensor **M**agnetic **P**hase **T**heory (*TMPT*) [2]. Measurements and observations are performed with the **S**ingle **S**heet **T**ester (SST) and the **M**agneto-**O**ptical **I**ndicator **F**ilm (MOIF) technique. The analysis helps specifying the process thanks to a relative control of the magnetic structure and its dynamic properties.

Impact of Groove Depth × LISW pressure ($p \times \acute{P}$)

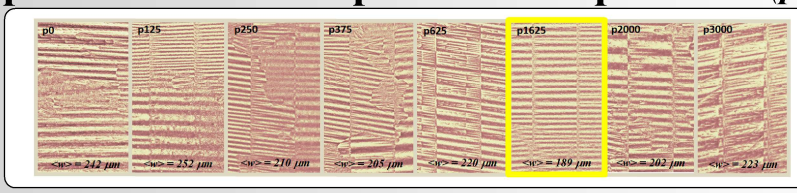
Process parameters

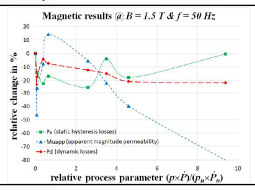
***p*: groove depth**
***Ṕ*: LISW pressure** (Laser Shock Wave)
p': affected depth
(**)

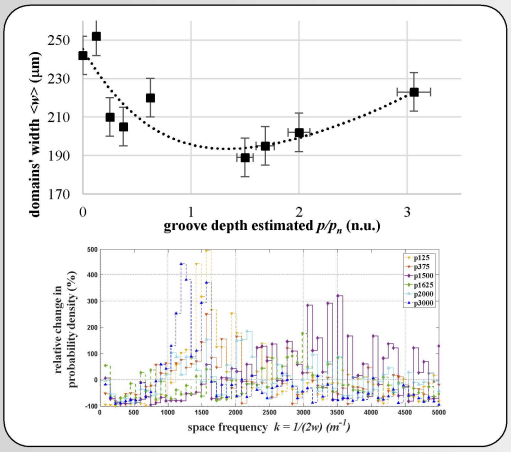


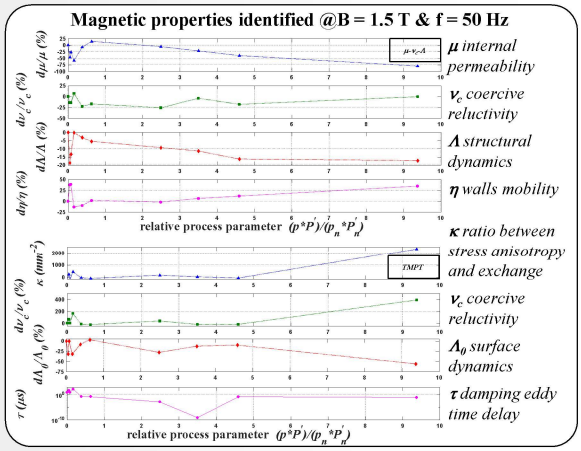
samples	p/p_n	$\acute{P}/\acute{P}_n$
p0	**0**	**0**
p125	**0,125**	**0,61**
p187	**0,187**	**0,26**
p250	**0,250**	**0,64**
p375	**0,375**	**1**
p625	**0,625**	**1**
p1500	**1,5**	**3,06**
p1625	**1,625**	**1,53**
p2000	**2**	**1,75**
p3000	**3**	**3,06**

**: *relative to nominal p_n and $\acute{P}_n$*





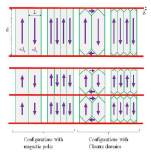




Impact of Laser Lines' Spacing *d*

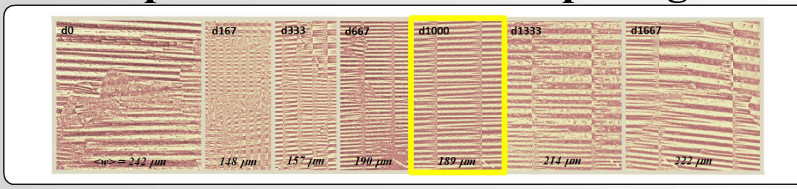
Pattern parameters

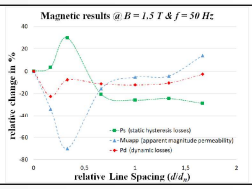
***d*: pattern line spacing**
δ: line width groove width
(***)

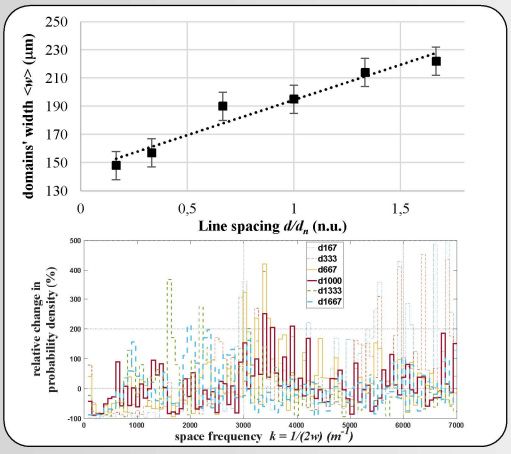


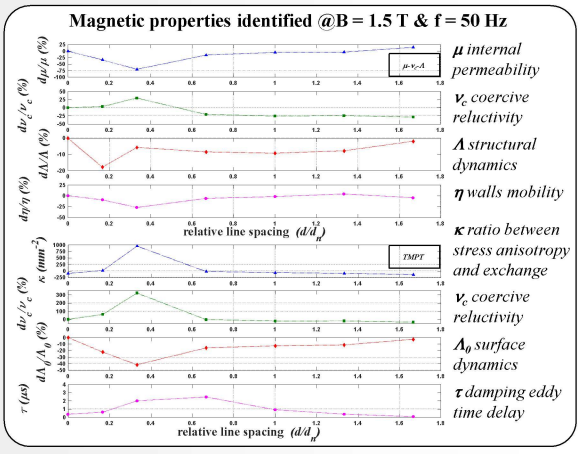
samples	d/d_n
d0	**0**
d167	**0,167**
d333	**0,333**
d667	**0,667**
d1000	**1**
d1333	**1,333**
d1667	**1,667**

***: *relative to nominal d_n*









Conclusion: The technical solution is a compromise between

- The inclusion of located laser spots – lines, that leads to : a reduction of polarization inside the affected zone (***Ṕ*** ⇒ μ, κ) / an increase of pinning – nucleation processes at defects (***p*** ⇒ v_c).
- The induction of located closure domains or magnetic poles that define width of magnetic domains, multiplication and mobility of walls driven by the total energy minimization (***d*** ⇒ Λ, η, τ).

Solution proposed

p/p_n	$\acute{P}/\acute{P}_n$	d/d_n
1,5	**1,5**	**1**

*: olivier.maloberti@unilasalle.fr / olivie.maloberti@gmail.com; [1] Maloberti O. et al., JMMM, vol. 304, issue 2, Sept. 2006, Pages e507-e509; [2] Maloberti O. et al., JMMM, vol. 502, (2020), 166403.

The project ESSIAL received funding from the European Research Council under the European Union's H2020-IND-CE-2016-17/H2020-FOF-2017 Program (Grant Agreement No. 766437).