Call for 1 Post-doc

Topic: Development of a rapid laser surface treatment of printed metal parts for resistance to fatigue and wear

Summary of the position and institute

- 2-year post-doc position
- Supervisors: Véronique Doquet and Manas V. Upadhyay
- Affiliation: LMS, CNRS, Ecole Polytechnique, Institut Polytechnique de Paris
- Tentative start date: October 1, 2024
- Application deadline: July 1, 2024

General context

Metal parts from additive manufacturing generally have high surface roughness, as well as residual tensile stresses which adversely affect their fatigue resistance. Heat treatments and/or long and expensive polishing are then necessary to improve this resistance. The project aims to replace them with very fast, more economical and more energy efficient laser treatment.

Technical developments recently carried out at the LMS have led to the coupling of a laser with a scanning electron microscope [1]. These developments were followed by work on 316L and 316L-Si stainless steel walls from 3D printing (DED machine available at LMS), which showed that high-speed surface treatment using a laser of small spot size (inside the SEM) makes it possible to increase their endurance limit by 25% [2]. This beneficial effect has been attributed to a reduction in surface roughness and a strong refinement of the microstructure (dislocation cells and chemical micro-segregation cells) which was accompanied by an increase in the elastic limit, without any loss of ductility. However, the impact of the change in residual stresses induced by the laser treatment on the fatigue properties was not fully understood.

References:

[1] Patent (under evaluation): A. Tanguy, M. V. Upadhyay, J. G. Santos Macías, “System to treat samples using a continuous-wave laser and characterize them using an SEM”. Submission date: 16 Dec 2022

[2] J. G. Santos Macías, A. Tanguy, K. Chen, L. Cornet, M. Vallet, M. V. Upadhyay. “Post-process lasering improves strength-ductility tradeoff and fatigue limit of additively manufactured stainless steels.” Preprint: https://hal.science/hal-04530203

Project and tasks

Additional work is thus necessary to realize these promising perspectives. First, the protocol for studying the effects of micro-lasing on fatigue resistance must be improved, via the direct printing of cylindrical specimens (instead of walls) and their laser treatment in a single phase, the sample being rotated around its axis (instead of the consecutive treatment of each face, which introduces an asymmetry of their residual stress state). Technical developments are already in progress at LMS to allow such treatment inside the SEM.

Using this modified device, the recruited post-doc will have to optimize the micro laser treatment for stainless steel, and thus fully clarify the effect of the process parameters on the microstructures formed on the surface, the residual stress state, the tensile behavior, the mechanisms of fatigue damage or wear, and their consequences in terms of durability.

Candidate profile

- A Ph.D. in Mechanical Engineering, Materials Science and Engineering or equivalent obtained after January 2024. Interested candidates graduating before October 1, 2024 can also apply.
- Proven skills and experience in mechanical testing (at least tension and fatigue) and microstructural characterization techniques (SEM, EBSD, EDS, XRD…) acquired during a Ph.D.
- Good communication (oral and written) skills in English. Applicants from non-English speaking countries should provide factual information on their proficiency in English.

Interested candidates please send an email to the address below with

- 1-page motivational letter
- Up-to-date and detailed CV
- Contact information of at least 2 referees willing to provide recommendation letters on your behalf

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and
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