RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Materials Science, Mechanics, Fluids

Subfield: Mechanical Engineering

Title: Surface integrity of Ti-6Al-4V alloy components produced by SLM and machining processes: multiphysics simulations and experimental validation.

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: José Outeiro, Arts et Metiers Institute of Technology
Abdelhadi Moufki, University of Lorraine
Advisor(s) Email: jose.outeiro@ensam.eu / abdelhadi.moufki@univ-lorraine.fr
Research group/Lab: LABOMAP and LEM3
Lab location: Cluny and Metz, France.
(Lab/Advisor website): http://labomap.ensam.eu/
http://www.lem3.univ-lorraine.fr/

Short description of possible research topics for a PhD:

Selective Laser Melting (SLM) is an additive manufacturing (AM) process used to produce functional prototypes and small series of Titanium alloys components with high mechanical properties and high geometrical complexity. Additionally, to obtain a functional product with geometrical/dimensional and surface integrity requirements, the components produced by SLM need to be finished using a machining process. The rapid cooling of the material during SLM leads to thermally induced residual stresses distributions in the components. These stresses can affect the machining process, causing part distortion and poor surface integrity. This will affect the functional performance and life of the titanium components, such as fatigue life and corrosion resistance. In this work, the physical phenomena and the surface integrity of Ti-6Al-4V alloy generated by both SLM and machining processes will be investigated using Multiphysics Simulations, carefully validated by experimental tests. The aim of Multiphysics Simulations is to determine the SLM and machining processes conditions that will enhance the surface integrity of SLM-produced components.

Required background of the student:
The candidate should have a knowledge of the finite element (FE) method, MATLAB programming language and continuum mechanics.

A list of 5 (max.) representative publications of the group:

1. K.S.Djaka, A.Moufki, M.Nouari, P.Laheurte, A.Tidu. A semi-analytical modelling of cutting using crystal plasticity theory and flow line approach. Int. J. of Mechanical Sciences, 146-147, 49-59, 2018.

2. A. Moufki, D. Dudzinski, G. Le Coz, Prediction of cutting forces from an analytical model of oblique cutting, application to peripheral milling of Ti-6Al-4V alloy, International Journal of Advanced Manufacturing Technology, 81 (1-4), 615-626, 2015.
3. X. Xu, Jun Zhang, J.C. Outeiro, B. Xu, W. Zhao. Multiscale simulation of grain refinement induced by dynamic recrystallization of Ti6Al4V alloy during high speed machining. Journal of Materials Processing Technology, 286, 116834, 2020.
4. W. Cheng, J.C. Outeiro, J.P. Costes, R. M'Saoubi, H. Karaouni, V.P. Astakhov. A constitutive model for Ti6Al4V considering the state of stress and strain rate effects. Mechanics of Materials, 137, 103103, 2019.
5. I.S. Jawahir, E. Brinksmeier, R. M'Saoubi, D.K. Aspinwall, J.C. Outeiro, D. Meyer, D. Umbrello, A.D. Jayal. Surface Integrity in Material Removal Processes: Recent Advances. CIRP Annals - Manufacturing Technology, keynote paper, 60 (2), 603-626, 2011.