**Research Topic for the ParisTech/CSC PhD Program**

***(one page maximum)***

****Field (cf. List of fields below): 8***

***Subfield***: (Applied Physics, Chemistry, Mathematics, Mech. Eng. etc…)
Processes,Mechanics,Materials Science

***Title***:Machining of Ti-6Al-4V parts produced by Selective Laser Melting (3D printing): Multiphysics approach and Virtual Simulations

***ParisTechSchool***: Sciences des Métiers de l'Ingénieur(SMI)

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***Short description of possible research topics for a PhD***: (10-15 lines in English + optional figure)

3D printing, also referred to Rapid Prototyping (RP), is a manufacturing process to directly generate physical objects with defined structure and shape from a virtual 3D model data. One of the most promising technique is Selective Laser Melting (SLM). The SLM process is based on a high energy laser that melts the powder particles. In the aerospace industry, SLM is used to produce functional prototypes and small series of Titanium alloys parts with high mechanical properties and high geometrical complexity. Additionally, to obtain a functional product with dimensional and structural requirement of industrial parts, the components produced by SLM requires a machining step. Due to their material properties (high mechanical tensile strength retained at high temperature; low modulus of elasticity; low thermal conductivity; high chemical reactivity), titanium alloy Ti-6Al-4V is classified as a difficult-to-machine material. Besides, during SLM process, the rapid cooling of the material leads to thermally induced residual stresses. Thus, initial state of SLM-produced can affect the machining operation and have a significant influence on the functional performance and life of components. Surface integrity of machined workpiece plays a critical role in the mechanical characteristics of machined components such as fatigue life and corrosion resistance. Therefore, the relationship between the effects of the manufacturing processes SLM-Machining and the surface integrity has to be investigated deeply for titanium alloy Ti-6Al-4V. In this work, surface integrity will be investigated using both modeling and experimental approaches. The purpose of the modeling part is to perform Multiphysics Simulations in order to understand the interactions between several physical phenomena.

***Required background of the student***: (Which should be the main field of study of the applicant before applying)

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:*** (Related to the research topic)

[1] 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), 2011, 603-626.

[2] 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, 2018, 49-59.

[3] 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), 2015, 615-626.

[4] L.A. Denguir, J.C. Outeiro, G. Fromentin, V. Vignal, R. Besnard, A physical-based constitutive model for surface integrity prediction in machining of OFHC copper, Journal of Materials Processing Technology, Vol. 248, pp. 143–160, 2017

[5] Z. Pu, G.-L. Song, S. Yang, J.C. Outeiro, O.W. Dillon Jr., D.A. Puleo, I.S. Jawahir, "Grain Refined and Basal Textured Surface Produced by Burnishing for Improved Corrosion Performance of AZ31B Mg Alloy", Corrosion Science, Vol. 57, pp. 192-201, 2012 (ISSN 0010-938X; I.F. 5.245).