

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Materials Science, Mechanics, Fluids

Subfield: Mechanical Engineering

Title: Study of the performance of recycled CO₂ as cryogenic assistance in machining process: experimentation and numerical simulation

ParisTech School: Arts et Métiers Sciences et Technologies

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Research group/Lab: Arts et Métiers, ParisTech, LaBoMaP, UBFC

Lab location: F-71250 Cluny, France

(Lab/Advisor website): <http://labomap.ensam.eu/>

Short description of possible research topics for a PhD:

The machining industry is constantly looking for new solutions to increase productivity and the quality of finished products. Machining assistance is one of the most effective ways to increase chip rate and maintaining the tool-life. The traditional use of cutting fluids like lubricants oil based has a strong impact on the ecology and economy of the process (recycling, cleaning, etc.). The objective of this project is to study and optimize the cutting process under recycled supercritical CO₂ as cryogenic assistance. The study will be realized on Titanium's alloys following two steps:

- 1- Identification of the cutting mechanisms: The intense cooling of the primary cutting zone induces modifications of the constitutive laws of materials. The shear and flow mechanisms of the material are concerned. Numerical simulation of material behaviors will be used to validate experimental tests.
- 2- Study the tribology of the interface between the tool and the workpiece : Experimental and numerical investigation will be carried out on tribometer, The real conditions will be taken into account to develop a wear model under cryogenic assistance.

Required background of the student:

1. A master's degree in mechanical engineering. The candidate must have a good knowledge in machining techniques and a strong taste for rigorous implantation of highly instrumented experimental procedures. He (or she) must have good programming skills in numerical simulation.
2. Ability to work independently, to plan and carry out tasks
3. Good communication skills in English, written and spoken.

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

1. Merzouki J, Poulachon G, Rossi F, Ayed Y, Abrivard G. Effect of cryogenic assistance on hole shrinkage during Ti6Al4V drilling. The International Journal of Advanced Manufacturing Technology (2020), 108:2675–2686. <https://doi.org/10.1007/s00170-020-05381-z>
2. Merzouki J, Poulachon G, Rossi F, Ayed Y, Abrivard G. Method of hole shrinkage radial forces measurement in Ti6Al4Vdrilling. Procedia CIRP, 16th

- CIRP conference on Modelling of machining operations (16th CIRP CMMO) (2017), 58:629–634. <https://doi.org/10.1016/j.procir.2017.03.226>
3. Lequien P, Poulachon G, Outeiro J.C. Thermomechanical analysis induced by interrupted cutting of Ti6Al4V under several cooling strategies. CIRP Annals, Manufacturing Technology (2018), 67(1). <https://10.1016/j.cirp.2018.03.018>