PhD Position 2023 at CEMEF in October 2023

Experimental design & thermo-mechanical modeling of HFQ process on AA2219 (CEMEF and Airbus)

General context

In the context of necessary carbon emissions reduction, development of new alloys and processes for materials forming in the aeronautic industry are prolific research topics. Hot Forming Quench (HFQ) is a disruptive forming technology which enables to obtain complex shapes at lower cost compared to traditional aluminum manufacturing processes. It allows designers and engineers to create freely complex shapes of the parts with high geometrical and aerodynamic performance tolerance using thin wall Ultra High Strength aluminum (2xxx, 6xxx, 7xxx alloys). HFQ is an alternative to conventional deep drawing process combined with heat treatments which allows simplified complex manufacturing routes, hence highly reducing carbon emissions of the process.

Figure 1. HFQ represents an efficient alternative process for different parts of planes' structure

Airbus is a strong advocate of innovative technologies to reduce Buy-to-Fly ratio, to improve integration & cost saving. HFQ is considered to be an important technology pathway to achieve this ambition. However, because of its novelty, the understanding of the mechanical and metallurgical aspects of the HFQ process needs to be developed.

As a first step in a global collaboration strategy between CEMEF (Mines Paris) and Airbus, two PhD positions are proposed. The research topics are briefly described since only few informations on the HFQ process and Airbus parts of interest can be presented for confidential reasons. The originality and success of the overall project relies on the complementarity between the two PhD projects. **The candidates will have the opportunity to develop advanced skills in aluminum metallurgy, thermomechanical design of laboratory experiments and numerical simulations applied to the development of new parts for future zero-emission Airbus aircrafts.**

This PhD aims at a better understanding of the HFQ process through the design of a laboratory test coupled with the development of a numerical model able to address the full complexity of this thermo-mechanical process. The main challenges rely on the **relationship between HFQ process conditions, induced microstructure and corresponding in-use properties**. This understanding, coupled with a representative numerical modeling of the process will provide both understanding and control of the HFQ process for Airbus in the manufacturing of their parts.

- Design and development of a laboratory HFQ testing device
    - Development of an in-house deep-drawing device with control of sheet and punch temperatures
    - Adapted Digital Image Correlation (DIC) and temperature measurements to follow the thermomechanical loading path during the test
    - Development of adapted thermomechanical loading paths to match the industrial ones
    - Design of specific microstructures (based on process parameters and T°) as input to PhD2
- Numerical modeling of the HFQ process
    - Thermal transfer analysis and modeling thanks to the experimental device. Transfer coefficients are of prime importance for accurate numerical simulations
    - Numerical modeling of the HFQ process (Abaqus) & validation of the numerical modeling strategy through both thermal and mechanical measurements

- **Keywords:** thermomechanical process design, advanced numerical simulations, microstructure induce final properties
- **Candidate profile:** Master or engineering degree with expertise in non-linear solid mechanics and thermomechanical behavior of materials. The PhD will address both experimental and numerical aspects of the process. The candidate will therefore have to demonstrate a good experience in one of these 2 aspects and a great motivation to develop the second during the PhD.
- **Localization:** The PhD will start at CEMEF (Sophia Antipolis) for 2 years and the last year of the PhD will be at Airbus Nantes
- **Salary:** 2700 €/month (gross salary)
- **Application:** Candidates applications should be sent by email and should include a CV, academic reports for the last 3 years and 1 or 2 recommendation letters from internship advisors or Professors.
- **Contacts:** pierre-olivier.bouchard@minesparis.psl.eu & katia.mocellin@minesparis.psl.eu

Application online only : fill in the form on line : https://applyfor.cemef.mines-paristech.fr/phd/