Constellium

WHO WE ARE?

Constellium is a global leader designing and manufacturing innovative and high value-added aluminum products and solutions for a broad range of applications dedicated primarily to aerospace, automotive and packaging markets. Constellium Technology Center (C-TEC) based in Grenoble (Voreppe - 38) is Constellium' s European research center with 246 employees and 20 nationalities.

Job title of the mentor: R&D engineer(s)

International internship : No

Starting date : 1st quarter 2025

School / university : Engineering school (Materials Science)

Department: Modeling and Applications

Internship total length : 6 months

Your mission

Impact of crystallographic texture on bending performance of Al alloys for automotive

Key words: 6xxx aluminium alloys, Automotive outer panels, Instrumented bending test, Digital image correlation, Crystallographic texture, Crystal plasticity simulations

Context:

Due to its low density, aluminium (Al) is a key material for sustainability as it allows lightweighting. In order to decrease the CO_2 emissions associated with its production, it is required to massively use recycled aluminium, meaning remelting Al scrap to make new ingots. However, switching from primary synthesis (bauxite reduction) to secondary synthesis (scrap melting) often leads to increasing impurities, the main one being iron in aluminium. Such contaminants may impact the performance of the current alloys in terms of ductility/formability, especially on sharp edges. It is the case of automotive outer panels that are bent around the inner part after stamping. The project of the internship is linked to microstructure optimization, and especially crystallographic texture (meaning grain orientations and their spatial arrangement), in order to mitigate the detrimental effects of impurities. Thus, it is key to identify how grain microstructure could be tuned to maintain current product performance, while increasing recycled content. For that, Constellium C-TEC has integrated within its modeling tools an open-source software, Damask, allowing to model the mechanical behavior of grains aggregates under different loading types. In parallel, SIMaP laboratory, located near Grenoble, is an academic partner with extensive experience in the experimental characterization of the relationship between microstructures and mechanical properties. It has recently invested in a fully instrumented bending set-up, allowing to measure local deformations at the surface of the specimen while bending. This internship is a collaboration between C-TEC R&D center (mostly modeling work) and SIMaP laboratory (mostly experimental work).

Objectives:

The objective of the project is thus to better understand the impact of crystallographic texture on the bending performance of 6xxx aluminium alloys for automotive applications.

The project has several components:

- ✓ Literature review to identify failure mechanisms in bending and analyze existing results
- ✓ X-Ray diffraction (XRD) measurements to measure global crystallographic texture, together with Electron Backscatter Diffraction (EBSD) to assess spatial arrangement of grain orientations
- ✓ Building of a numerical twin of the microstructure to be loaded in bending with Damask software
- ✓ Mechanical testing instrumented by Digital Image Correlation
- ✓ Damage quantification by post-mortem sample analysis
- ✓ Identification of relevant indicators to quantify strain localization for both simulations and experimental trials
- ✓ Comparison between simulations and experiments for identifying which type of texture should be

promoted to enhance bending performance
- ✓ Analysis and synthesis of the results, report writing and presentation to the team

At C-TEC, the intern will be part of a R&D team of engineers with expertise in metallurgy and mechanics. In addition, the candidate will spend about 50% of his internship with the academic partner (GPM2 group consisting in 15 researchers and several PhD and post-doctoral students) for the experimental work.

Profile

Education level: Engineering school or Master of Science

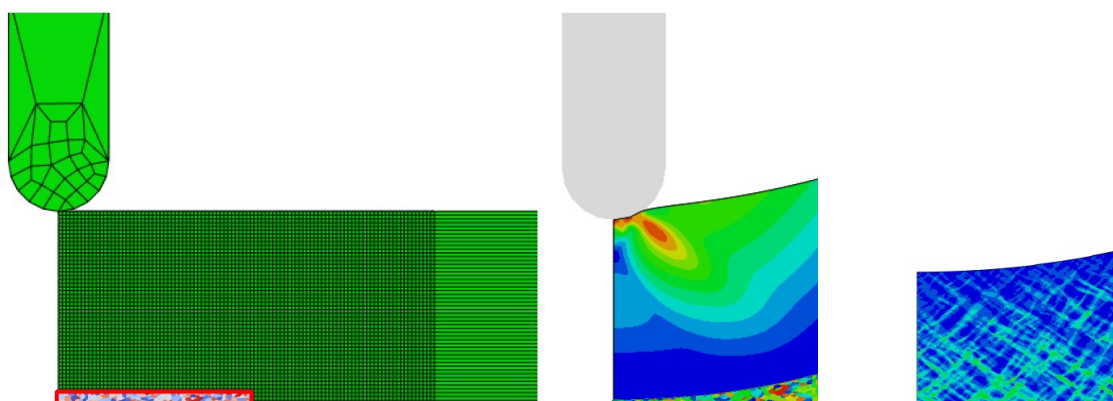**Competencies (technical & soft skills requirements):**

- *Good knowledge in mechanics and physical metallurgy*
- *Motivation for both modeling and experimental work*
- *Strong capacity to post-treat a significant amount of data from both simulations and experiments*
- *Serious, autonomy, critical mind and creativity*
- *Candidate interested in research and development (possibility to pursue with a PhD)*
- *Good English level, both written and spoken*
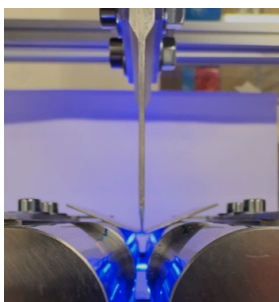
Laboratory bending test set-up

Industrial application: Hemming

2-scale bending modeling