Effect of impurities on damage nucleation and bendability of recycled aluminium alloys.

Context of the project

In terms of sustainability, aluminum alloys are known to be materials of choice. They allow lightweighting and thus fuel consumption reduction due to their low density. However, producing aluminum from bauxite ore is very energy intensive and today's aluminum industry represents 2% of the global greenhouse gas (GHG) emissions. Recycling aluminum allows both energy savings and a drastic reduction of GHG emissions, because only 5% of the energy required for primary synthesis (ore reduction) is needed to remelt aluminum scrap. However, reaching high levels of recycled content leads to contamination by tramp elements, the main one being iron. As these elements typically have a low solubility in aluminum, they are integrated in intermetallic phases, negatively impacting product properties such as formability and in-service ductility. The current challenge lies in finding solutions to mitigate this detrimental effect, in order to meet demanding properties in spite of higher impurities contents.

The PhD is part of a very ambitious project (ANR RecycAl with 3 PhDs) involving complementary expert teams in the field: Constellium for the material supply, material formulation and industrial application, CMAT Mines Paris PSL for the in-situ synchrotron observations of ductile failure mechanisms under plane strain tension, SIMAP INP Grenoble for the in-situ synchrotron observations of ductile failure mechanisms under plane strain bending and CEMEF Mines Paris PSL for 3D modeling of ductile damage mechanisms of heterogeneous microstructures.

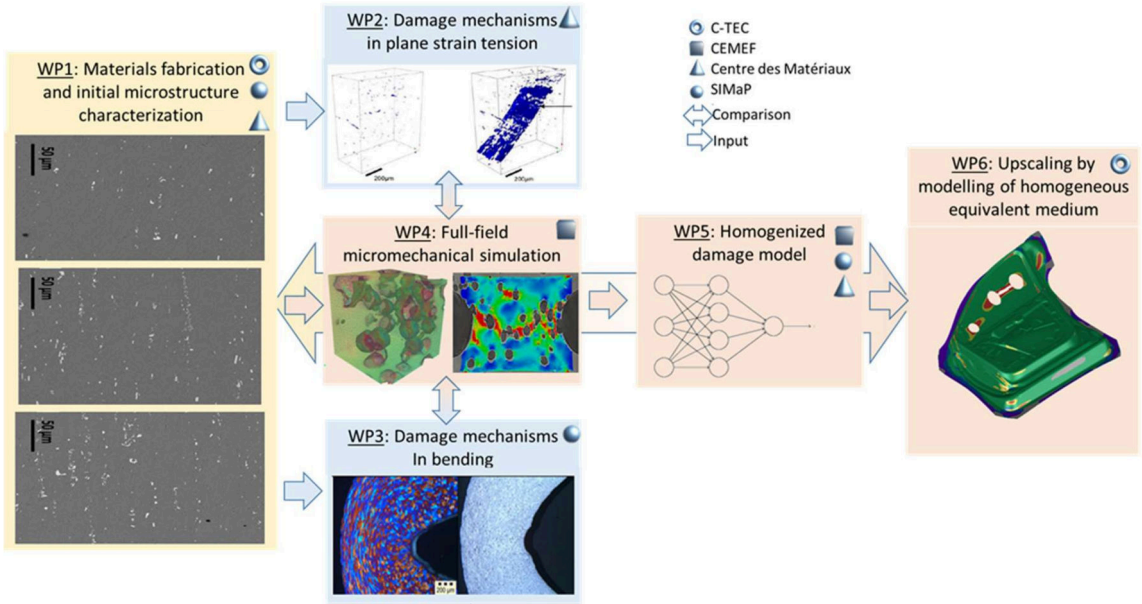


Figure 1: ANR RECYCAL Work Packages and Organization.

This PhD hiring is devoted to the 4D characterization of ductile failure mechanisms under plane strain bending. Macroscopic instrumented tests (DIC on external surface, bending load, bending angle) will be carried on at the SIMAP lab. 3D in situ X-ray characterization will be conducted using laboratory and synchrotron sources and will be coupled to digital volume correlation and 2D EBSD ex-situ characterization. It will lead to the identification of damage mechanisms for different impurity contents and textures. Results will be compared to micromechanical simulations.

PhD program and PhD applications requirements

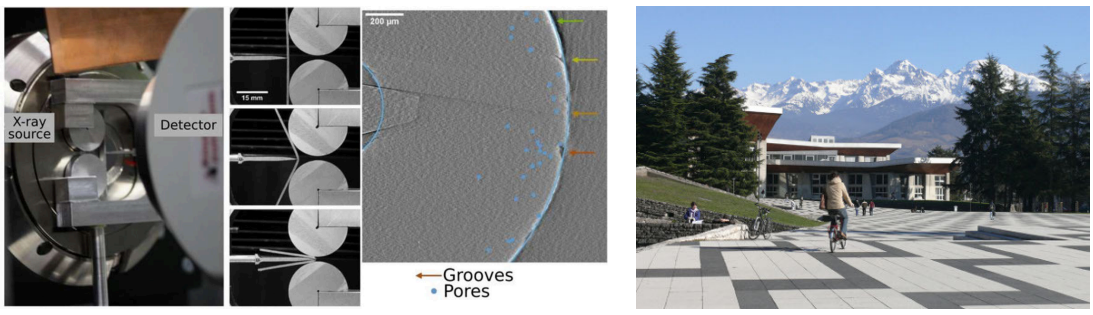
This PhD offers a unique opportunity to develop cutting-edge experimental methods to address multi-scale ductile damage and fracture of recycled aluminum alloys. Thanks to the international renowned expertise and complementarity of the 3 research teams, the project should lead to many important scientific publications. The major role of Constellium in the Aluminum industry is also a guarantee of industrial-oriented research and applications in various fields (aeronautics, automotive, packaging).

Considering the ambition of the project, only high level of excellence applications will be considered with the following profile:

- Masters-level degree or graduate of Engineering school in Mechanics, Materials or Physics with good knowledge in solid mechanics;
- Strong motivation for experimental based advanced approaches;
- Strong analytical skills, including general coding abilities (python/matlab);
- Knowledge in image analysis would be a plus;
- Ability to work/interact with both academic and industrial teams;
- The PhD student is expected to be self-motivated, creative, and capable of critical thinking.

PhD conditions

- Starting date: October 2024 or earlier
- Duration: 3 years
- Research laboratory and Location : Laboratory of Science and Engineering of Materials and Processes (SIMAP), Grenoble, France. Close collaboration and interactions with CONTELLIUM
- Academic supervision: Pierre LHUISSIER and Luc SALVO (SIMaP - CNRS - Univ. Grenoble Alpes)
- Industrial supervision within the ANR RECYCAL Project: Fanny MAS
- Interested? Please send your application to pierre.lhuissier@simap.grenoble-inp.fr



(a) (b)

Figure 2: (a) Preliminary in situ experiments. (b) Grenoble campus.