Phd position 2018 – 2021
CEMEF (Mines ParisTech) collaboration with VMZinc Umicore

Optimization of zinc alloys microstructure for improved and stabilized mechanical behavior and formability
Project OSCAR

Context

VMZinc (ex Umicore) is an international industrial group specialized in the elaboration, processing and treatment of non-ferrous alloys. VMZinc is known worlwide to be an innovative-oriented and forward-looking company.

Its activities in materials science, chemistry and metallurgy make VMZinc a major player in the international industry and scientific research.
Regarding the building field, VM Zinc Building Products is the international leader of rolled zinc alloys. Used essentially for buildings roofs and fronts or for storm water collection systems, zinc alloys is known for its very good properties with respect to ageing and its ability to be formed into complex shapes.

VMZinc Building products has a 10 years old partnership with CEMEF (the Mines ParisTech research center dedicated to materials processing and located at Sophia-Antipolis) in order to improve the quality and durability of its products. The dynamic research conducted these last years enabled to get a significant expertise in zinc alloys forming process conditions. Some of these studies were dedicated to the strong anisotropic behavior of VMZinc alloys as well as its formability (ability to be deformed without fracture) and the variability of its material behavior.
The goal of this PhD is to optimize zinc alloys microstructure in order to improve its final mechanical behavior as well as its formability.

Detailed presentation and objectives

Zinc's simple hexagonal crystal structure combined to the strong basal texture of rolled sheets give rise to a very strong anisotropic behavior. Improving Zinc's mechanical properties is obtained thanks to the addition of alloying elements (titanium for creep resistance, copper for improving its strength to fracture or magnesium for reducing grains size). Zinc sheets are obtained by continuous casting, followed by multiple rolling stages which parameters (number of stages, reduction ratio …) have a significant influence on final microstructure and final mechanical properties.

Based on previous studies, VMZinc was able to work out an optimization loop including a global approach from production to modeling and including metallurgical and mechanical analyses (fig. 1). However, the relation between process parameters, resulting microstructure and associated mechanical properties and formability is not yet understood. This is why VMZinc wishes to improve its understanding and knowledge related to formability mechanisms and is looking for a way to optimize rolled zinc alloys microstructure in order to improve final in-use properties and formability. This issue is even more important due the high level of variability coming both from the material and its industrial process conditions, which makes the understanding of microstructural mechanisms all the more essential for a better prediction of macroscopic properties.

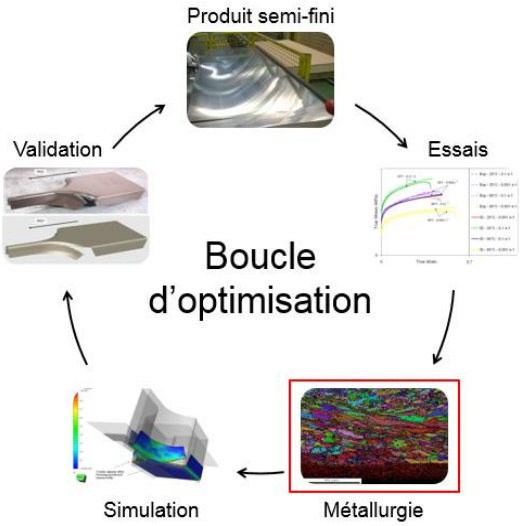

Figure 1 Integration of microstructural evolution mechanisms into the optimization loop "production – process conditions – final properties"

The goal of this PhD will be to study the different microstructural mechanisms related to the various production process conditions (casting & rolling) and to understand their impact on final microstructure, mechanical behavior and formability.

To reach this goal, the PhD student will be able to address the whole chain of zinc alloys sheet production, from early stages elaboration to final mechanical behavior. He/She will observe zinc alloys microstructure (microscopy, SEM, DRX, EBSD) study its material behavior laws (plasticity & anisotropy), its formability and proceed to the numerical modeling under various loading conditions.

The PhD student will benefit from lectures in materials science, non-linear solid mechanics, damage and fracture. These competences will provide opportunities to develop future activities in various R&D sectors in energy, transport and metallurgical industries.

Skills & abilities requested

Degree: MSc or MTech in Metallurgy, Materials Science, Non-linear Solid Mechanics or Computational Mechanics, with excellent academic records. Skills: Metallurgy, non-linear solid mechanics, proficiency in English, ability to work within a multi-disciplinary team.

Location

The 3-year PhD will take place at CEMEF, an internationally-recognised research laboratory of MINES ParisTech located in Sophia-Antipolis, on the French Riviera. It offers a dynamic research environment, exhaustive training opportunities and a strong link with the industry. Annual gross salary: around 27k€. She/He will join the Computational Solid Mechanics (CSM) team under the supervision of Pierre-Olivier Bouchard Short visits at IFIR (University of Rosario, Argentina) will be scheduled all along the PhD and a tight collaboration with VMZinc is expected.

Application

The application file should be sent to both people below and must include 1 CV, A motivation letter, academic records as well as 1 or 2 recommendation letters.

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