Research Grants for PhD students from the China Scholarship Council

Information Form (please read the guidelines carefully on the website www-csc.utt.fr)

Supervisor's name : LEBBAL Given names : Nadhir

Status (prof., assistant prof., …) : Prof HDR

Laboratory : ICB-UTBM-COM/ FEMTO-ST Website address : https://icb-comm.utbm.fr/

Institution : UTBM Website address : https://www.utbm.fr/

Scientific competence of the supervisor:

The supervisor's research interests include optimization and numerical modeling in multi-physics, particularly in structural mechanics, thermal analysis, and fluid dynamics. He develops model-based design tools and optimization methods integrated with numerical simulations to enhance the interaction between products, processes, and materials. Additionally, he employs surrogate modeling techniques from the field of artificial intelligence (AI) to replace complex process models by learning from numerical simulations, thereby accelerating the optimization process.

Two major publications in the field proposed for the PhD :

1. Y. Liu, D. Chabane, and O. Elkedim, “Intermetallic compounds synthesized by mechanical alloying for solid-state hydrogen storage: A review,” Energies (Basel), vol. 14, no. 18, Sep. 2021, doi: 10.3390/EN14185758.
2. N. Lebaal, Robust low cost meta-modeling optimization algorithm based on meta-heuristic and knowledge databases approach: Application to polymer extrusion die design, Finite Elem. Anal. Des. 162 (2019) 51–66.

Website address of the personal page : https://scholar.google.com/citations?hl=fr&user=KUS2PXwAAAAJ

Supervisor's email : nadhir.lebaal@utbm.fr

Description of the research work proposed for a PhD ***Topic # (see list) :*** V-5

Title : Optimizing High-Performance Metal Hydride Tanks for Electrochemical Energy Storage

Subject :

Electrochemical energy storage is a critical area of research in the development of sustainable energy technologies, including fuel cells and energy storage systems. Among the various storage solutions, metal hydrides have emerged as promising materials due to their high capacity for storing chemical fuels, safety, and potential for reversible electrochemical cycling. However, challenges related to thermal management and mechanical integrity significantly impact on their efficiency and long-term durability.

During absorption and desorption processes, metal hydrides undergo exothermic and endothermic reactions, generating significant temperature gradients that can hinder reaction kinetics and lead to localized overheating or cooling. This necessitates the optimization of heat transfer mechanisms to maintain efficient energy storage and retrieval. Furthermore, repeated absorption/desorption cycles induce volume expansion and contraction in the metal hydride material, leading to mechanical stress accumulation, fatigue failure, and potential structural degradation of the storage tank.

This study focuses on the multi-physics modeling and optimization of a metal hydride-based electrochemical storage system using COMSOL Multiphysics. The modeling will aim to enhance thermal management and mechanical stability

Keywords :

Multi-physical modeling, matal hydide, Comsol

Expected collaborations :

Background required from the applicant :

The potential candidate for this project should have expertise in multi-physics modeling, particularly with COMSOL Multiphysics, to simulate thermal, mechanical, and mass transfer processes in metal hydride systems. They should also be proficient in finite element analysis (FEA) to assess thermal and mechanical stresses in complex structures, as well as the non-linear behavior of materials under cyclic loading. Additionally, knowledge of metal hydride chemistry and the associated electrochemical processes for energy storage is highly appreciated. The candidate should also

Existence of a PDF file detailing the proposal ("yes" or "no") : yes

(see guidelines on the website www-csc.utt.fr)