Pole for Doctoral Studies
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ANNOUNCEMENT OF DOCTORAL THESIS DEFENSE

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Will present their research work with the aim of earning a Doctorate

Doctoral program: Science and Technique Engineering
Discipline: Energy and Materials Engineering
Specialty: Energy Materials and Physico-Chemical Engineering

On 12/02/2026 at 11H00 at the Conference Hall, "F" Building, Faculty of Sciences and Techniques of Tangier, UAE
Under the Theme

Development of Materials for Solid Oxide Fuel Cell (SOFC) Technology based on Local and Waste Mineral using Low-Cost Fabrication and Shaping Methods

Front of the jury composed of :

First Name & Last Name	Establishment	Designation
Pr. ACHAK Ouafae	FST of Tangier, UAE	President
Pr. JOUBERT Olivier	CNRS, Nantes Université, IMN of France	Reviewer
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Pr. MANSORI Mohammed	FST of Marrakesh, UCA	Examiner
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Host Research Structure: Chemical Engineering for Resources Valorization Group, FST of Tangier. Ref: UAE/U14FST

Abstract

The global demand for clean, efficient, low-cost, and environmentally friendly energy conversions solutions presents a significant challenge for engineers and scientists. Among the promising technologies, solid oxide fuel cell (SOFC) represents the highly efficient and environmentally clean, as they convert the chemical energy of fuel gases directly into electrical energy without combustion. So far, a key focus of current SOFC research is reducing both the cost of materials and the operating temperature to the intermediate temperature (IT) or low temperature (LT) range. Achieving this requires the development of alternative solid electrolytes that offer promising features, including high electrical conductivity, structural and thermal stability, and adequate densification at reduced temperatures.

In this context, it has been found that natural minerals, particularly iron-containing materials have emerged as promising candidates for energy conversion applications. This thesis presents an experimental investigation of solid electrolytes based on iron-cantoning materials: natural minerals (NM) and iron-rich mining waste, specifically waste hematite (WHM, Fe_2O_3). The WHM was obtained as a by-product of sulfuric acid (H_2SO_4) production through the oxidation of pyrrhotite (Fe_7S_8) in a fluidized bed furnace. The first part of this thesis focuses on the use of NM, identified as a mixture of hematite, silica, and illite, as a low-cost material. An empirical approach was applied to optimize the casting slurry composition for the fabrication of solid oxide pellets via casting method. Comprehensive morphological and electrical characterizations revealed that NM-based pellets achieved promising densification, electrical conductivity, and thermal stability, making them suitable candidates for SOFC electrolyte applications.

The second part of this thesis, investigates the valorization of mining waste WHM as a functional solid oxide electrolyte material. In addition, a composite strategy was employed to develop and investigate an intermediate layer suitable a for electrolyte-layer free fuel cell (EFFC) technology. The composite material was developed by incorporating a semiconductor $La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.8}O_{3-\delta}$ (LSCF), synthesized via glycine-nitrate method, into WHM matrix. The resulting semiconducting-ionic conductor LSCF-WHM composite demonstrated enhanced electrochemical performance, offering a promising pathway for the development of cost-effective materials for intermediate temperature EFFC applications. Finally, the initial fabrication attempts of several single cells utilizing NM- or WHM-based electrolytes demonstrated the practical feasibility of these materials in single cell configurations. Employing conventional techniques such as casting and screen-printing, these prototypes confirmed the compatibility of the synthesized electrolytes with standard cell manufacturing processes.

The aim of this thesis is to contribute to the advancement of alternative solid electrolyte and intermediate-layer materials by providing insight into their preparation methods, morphological and electrical properties. The obtained result paves the way to perspectives for designing high-performance, low-cost energy conversion systems, allowing broader goal of sustainable and accessible energy technologies.

Keywords: Natural minerals, iron-rich mining waste, hematite, semiconducting-ionic composite pellet, solid oxide electrolyte, state-of-the art materials, material characterization, electrical conductivity, electrochemical performance.