


IMT Mines Alès
École Mines-Télécom


SCIENCE & CREATIVITY TO INVENT A SUSTAINABLE WORLD

PhD Position in

Materials Process Science, Bioproducts, and Food

Institution	IMT Mines Alès (Ecole Nationale Supérieure des Mines d'Alès)
Main job assignment	Teaching and Research center C2MA
Administrative residence	Alès (Département du Gard – Région Occitanie)
Starting date	

1. Context

The Institut Mines-Télécom (IMT), a major institution within the meaning of the Education Code, is a public scientific, cultural and professional institution (EPSCP) placed under the principal supervision of the ministers responsible for industry and digital technology. It is the largest group of engineering schools in France, with 11 public engineering schools spread across the country, which train 13,500 engineers and PhDs each year. The ITM employs 4,500 people and has an annual budget of €400M, 40% of which comes from its own resources. IMT has 2 Carnot institutes, 35 industrial chairs, produces 2100 A rank publications annually, 60 patents and carries out 110M€ of contractual research.

Created in 1843, IMT Mines Alès currently has 1,400 students (including 250 foreigners) and 380 staff. The school has 3 research and teaching centers of high scientific and technological level, which work in the fields of materials and civil engineering (C2MA), environment and risks (CREER), artificial intelligence and industrial and digital engineering (CERIS). It has 12 technological platforms and has 1,600 partner companies.

2. Research project

Title: Geopolymer matrix Biocomposites for Housing in Africa – Valorization of Rice Husk as an Activator, Catalyst, and Reinforcement (BAGAR)

The proposed PhD project aims to develop geopolymer matrix biocomposites to address the issue of sustainable housing in Africa by utilizing rice husk, an abundant local resource, both as an activator and as a reinforcement. As a sustainable alternative to traditional cement, geopolymers are less energy-intensive and, more importantly, less polluting, as they emit lower CO_2 levels. The project will focus on developing geopolymers from rice husk ash, reinforced bricks incorporating agricultural waste fibers, and coatings designed to enhance the durability of locally available materials, such as earthen bricks and recycled plastics.

The experimental work will be conducted under extreme climatic conditions (97% relative humidity, temperatures around 0°C, etc.) to develop sustainable building solutions that integrate both circular economy principles and environmental footprint reduction. This project aims to combine mechanical, thermal, and durability performance with tropical climatic conditions and low production costs. Geopolymer-based coatings will be designed to improve the water resistance of locally produced earthen and recycled plastic bricks. The proposed solution responds to the increasing housing demand in Africa, promotes sustainable construction, and reduces the environmental impact associated with conventional building materials.

Thus, this study will be structured around several key areas:

1) Synthesis of Geopolymers from Rice Husk Ash

The combined use of rice husk ash and other alumina sources, such as metakaolin, montmorillonite, or

a combination of both, will be explored to produce geopolymers.

2) Formulation of Geopolymer Matrix Biocomposites

Once the geopolymerization reaction using rice husk ash and other alumina sources is well understood and optimized, the next step will be to develop composite bricks reinforced with locally available lignocellulosic agricultural waste fibers. The reinforcing potential of various fibers, such as rice husk alone or combined with other agricultural residues, will be assessed by varying the fiber/matrix ratio and fiber granulometry.

3) Evaluation of the Physicochemical, Mechanical, and Thermal Properties of Biocomposites

This part of the research aims to characterize the developed biocomposite materials in terms of their physicochemical, mechanical, and thermal properties. Geopolymers are known for their excellent thermal stability, chemical inertness, and interesting mechanical properties. The characterization of the formulated biocomposites will assess the influence of a new precursor in the geopolymerization reaction, as well as the effect of fiber reinforcement on the overall properties of the geopolymers.

4) Geopolymer-Based Coatings for Existing and Widely Used Materials in Africa

Initially, the objective is to evaluate how applying a coating on earthen bricks can make them water-resistant while preserving their physicochemical, mechanical, and thermal properties.

A second objective is to explore the possibility of developing a coating for recycled plastic bricks to waterproof them and thereby limit the release of degradation by-products. These materials are often used for paving slabs in walkways but can undergo leaching with the first rainfall, leading to the release of micro- and nanoparticles that contribute to soil and groundwater pollution. The proposed coating would provide a sustainable valorization approach for recycled plastic bricks, preventing them from becoming merely another pollution source.

5) Study of the Aging of Biocomposites and Coated Materials with Geopolymer-Based Coatings

The durability of these materials under harsh climatic conditions, including temperature fluctuations, humidity, and UV exposure, will be assessed both in real-world conditions and in simulated laboratory environments.

Keywords: Biocomposites, Geopolymer Matrix, Reinforcement, Coating, Eco-Friendly Materials

3. Team supervision and PhD registration

Roland EL HAGE (Associate Professor, HDR), IMT Mines Alès, Materials Center of Mines Alès, Polymers, Composites, and Hybrids (PCH)

Rodolphe SONNIER (Professor), IMT Mines Alès, Materials Center of Mines Alès, Polymers, Composites, and Hybrids (PCH)

A collaboration with CIRAD is being considered, particularly with Amandine Viretto, PhD (Researcher, BioWooEB team).

4. Candidate profile

Candidates should hold a Master's or Engineering degree in Materials Science, Process Engineering, Civil Engineering, or Materials Chemistry, with knowledge of composite materials, polymer chemistry, and/or ceramics. Experience in the synthesis and characterization of bio-based materials, as well as in the development and formulation of composite materials, is required. A basic understanding of geopolymerization and binder chemistry would be a plus. The ideal candidate should be autonomous, capable of conducting a research project in collaboration, and possess strong scientific writing and result presentation skills.

5. Bibliographic References

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