Interreg France-Wallonie-Vlaanderen UNION EUROPÉENNE EUROPESE UNIE

ATHENS

IMT Lille Douai
École Mines-Télécom
IMT-Université de Lille

# PhD thesis position: Project ATHENS

## Laser welding assembly of thermoplastic composite parts reinforced with natural fibers: modeling and characterization

**Keywords:** laser welding, experimental characterization, numerical simulation, composites, heat transfer, mechanical behavior, natural fibers.

### Background:

Even if thermoplastic polymers are widely used for industrial and commodity products, their mechanical properties are not enough high to be employed for structural components. In general, reinforcing fibers (glass, carbon or natural) are added to increase the mechanical performance of thermoplastic parts. The use of fiber-reinforced plastics leads to design lighter structures for industrial applications while keeping the materials and structures stiff, strong and potentially recyclable. This is one of the effective ways to minimize vehicle weight and maximize payload for both freight and passenger transport, as a means of a global effort to reduce the ecological footprint. In this regard, natural fiber reinforced thermoplastic materials offer not only technological but also ecological solutions because the ecological impact of natural fibers during their production is lower than that of glass or carbon fibers. To manufacture complex structures, however, it is necessary to assemble a number of parts into a single structure. Indeed, the assembly technologies of composites such as laser welding are attracting great attention from the research and industrial communities. This thesis focuses on the laser welding joints and interfaces of thermoplastic parts reinforced with natural fibers.

### Scientific and technical objectives:

It is supposed to investigate the laser welding process for opaque natural fiber reinforced polymer (either opaque or transparent) by numerical modeling and experimental characterization. From an experimental point of view, it is necessary to determine the optimal parameters of the welding which can lead to the optimal quality of assembly by the experimental characterization of static and fatigue mechanical behaviors. The theoretical study of the interaction between laser beam radiation and materials (polymer matrix and natural fibers) will be performed through numerical simulation of laser welding. The effects of crystallization and intermolecular diffusion on the light transmission and interface adhesion will also be investigated. The mechanical behavior of welded parts will be predicted by taking into account the microstructural changes induced by welding process. The microstructural observation of fiber distributions and weld seams will be performed by SEM and optical microscope to provide input parameters for numerical simulation and validate the numerical models for light diffusion and mechanical behavior. In parallel, numerical simulations will be used to identify the thermal history of the material, which will be applied to the numerical computation and optimization of the mechanical strength of welded joints.

**Candidate profile:**

Successful candidates should hold a Master degree in engineering science or mechanical engineering with a strong background in heat transfer, solid mechanics and materials science (in particular, polymers and composites). Deep knowledge in numerical simulation (FEM, programming language such as Matlab and Python, etc.) is indispensable. The candidate should have a good level in English (speaking and writing).

**Duration:**

Three years; estimated start date: 01/October/2019. The gross salary is 1786 € per month (before taxation). Salary increases are planned at the end of the second and third years, according to the quality of the research results. The main place of work is IMT Lille Douai in Douai (France) with trips to the various cross-border project partners (KU Leuven, Materia Nova).

The applicants must send by email, a CV and a letter of motivation (and a couple of letters of recommendation).

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