Le Laboratoire Génie de Production
is looking for a candidate for a thesis entitled:

# Additive manufacturing by laser wire deposition (LMD-W) of an aeronautical alloy: Process - microstructure - mechanical properties relationships.

Additive manufacturing is now an important key of all industrial strategies. Based on innovations born in industry, resulting from a complex combination of technologies, including materials, production machines and design practices, it opens up new perspectives that are disrupting the value chain at all levels. It is a global market of more than €10.9 billion in 2018, and growing rapidly (CAGR of 22% between 2019 and 2025). In the field of high tech metal parts, the competition focused first on powder bed technologies. However, they have several limiting factors, such as the relatively small size of produced parts, amount of powder involved, and a low manufacturing speed.

Additive manufacturing with metal wire feedstock is still poorly considered worldwide and virtually non-existent in France. Difficulties concerning repeatability and stability of the fusion process have not been overcome in an industrial way. However, aerospace and defence sectors represent real opportunities for metres scaled metal components, manufactured in small or medium batches, considering that melting process should be perfectly mastered to guarantee very good metallurgical characteristics.

The work of the thesis will be essentially experimental by nature and will focus on characterisation of operating parameters influence (diameter and nature of the wires used, energy parameters, design strategy, etc.) on LMD-W produced material properties. After a necessary development of experimental setup, analyses will focus on metallurgy of the considered alloy during different stages of the process and resulting static mechanical properties. Microstructural study will therefore focus on as-build parts and heat treated parts. It will aim to determine, firstly, material health of the produced parts (heat-affected zone (HAZ) depth, presence of cracks and porosity). For optimised operating conditions, microstructural gradient at substrate/deposit interface and in resulting builds will be studied in detail in order to understand mechanical behaviour at different scales.

The development techniques used are those of the ESTIA Addimadour platform and the characterisation means necessary for this thesis work are available in the Laboratoire Génie de Production (scanning electron microscopy, X-ray diffraction, EBSD, X-ray micro-tomography, tensile tests with measurement of kinematic fields, in-situ tensile tests under SEM, etc.).

Financing of the thesis: MESR grant

Profile required:

- Engineer/Master 2 in materials

- Skills in metallurgy and additive manufacturing

- Good interpersonal skills and team spirit

- Taste for experimentation

- Autonomous

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