# Fabrication of Ni-based superalloys by Electron Beam Melting

**Edouard CHAUVET**

Supervisors: Jean-Jacques Blandin and Guilhem Martin

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Amphitheater Jean Besson (Phelma Campus)

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**Abstract**: Over the last decade, new processing routes based on additive manufacturing (AM) have emerged. Among the AM processes, Electron Beam Melting (EBM) was mainly dedicated to the fabrication of components made of titanium or chromium-cobalt alloys. Aeronautic industry has been a driving force to investigate the possibility to extend the EBM process to other materials and in particular to Ni-based superalloys.

The first objective of this work was to develop a methodology to rationalize the use of a new material in the EBM machine. This can be achieved by studying the main characteristics of the EBM process: powder requirements, melting parameters and strategies, thermal aspects.... The methodology was first validated on a weldable Ni-based superalloy: the Inconel 625 grade.

The methodology was then extended to the fabrication of a non-weldable Ni-based superalloy, i.e. a grade containing a large fraction of the γ' strengthening phase. Processing such non-weldable superalloys by EBM usually induced cracks in the fabricated components. The microstructures were characterized in order to identify the mechanism at the origin of the cracks. Understanding the mechanism responsible for the development of cracks has allowed to propose new melting strategies limiting or completely avoiding the formation of cracks.

Adjusting melting parameters and strategies turns out to be an efficient way for tailoring the grain structure. Equiaxed grains, columnar grains with different sizes as well as single crystals can thus be generated with suitable process parameters.

Finally, coupling a solidification model predicting the equiaxed/columnar transition and finite element calculations quantifying the magnitude of the thermal gradient and solidification velocity allowed to establish some links between microstructures and EBM melting parameters.

**Keywords**: Additive manufacturing, EBM, Superalloys, Hot cracking, Columnar to equiaxe transition, Single-crystal, Liquid film.