Investigation of the influence of the process parameters on the microstructure and fracture behavior of a Ni20wt.%Cr alloy produced by Laser Powder Bed Fusion

Doctorant·e
BENMABROUK SELIA

Direction de thèse
VIEILLE BENOIT (Directeur·trice de thèse)
HUG Eric (Co-directeur·trice de thèse)

Date de la soutenance
18/10/2024 à 14:00
Lieu de la soutenance
Locaux laboratoire GPM (Saint-Etienne du Rouvray)

Rapporteurs de la thèse
CORMIER JONATHAN ENSMA
GOURGUES-LORENZON ANNE-FRANÇOISE Ecole nationale supérieure des mines de Paris – PSL

Membres du jurys
CHARKALUK ERIC, , Ecole Polytechnique, Palaiseau
CHOISEZ LAURINE, , Université catholique de Louvain, Belgique
CORMIER JONATHAN, , ENSMA
GOURGUES-LORENZON ANNE-FRANÇOISE, , Ecole nationale supérieure des mines de Paris - PSL
HUG Eric, , Université de Caen Normandie
KELLER CLEMENT, , École Nationale d¿Ingénieurs de Tarbes - ENIT
VIEILLE BENOIT, , INSA de Rouen Normandie

Abstract
The fracture behavior of conventional nickel-based alloys (cast, wrought…) has been studied for decades for structural design purposes. However, the complex microstructure induced by metallic additive manufacturing processes results in different mechanical behaviors, which hinders the use of existing knowledge. To better understand the fracture mechanisms associated with these processes, this PhD research investigates the fracture behavior of a Ni20wt.%Cr alloy produced by Laser Powder Bed Fusion. The influence of three manufacturing parameters is studied: the building orientation (horizontal or vertical), the rotation angle between layers (67° or 90°), and the volumetric energy density (60 J/mm3 or 90 J/mm3). Crack propagation tests are conducted to determine and compare the fracture properties (fracture toughness and tearing modulus) of each printing strategy. Initial and post-mortem microstructures are analyzed to identify the fracture mechanisms. Results demonstrate that the crack propagation is mainly governed at the microscale, with a strong influence from the grain's orientation, morphology, and size. Ductility also becomes a key parameter when few differences are noted between the microstructural features of two given printing strategies.