Master Thesis Project

Investigation of Hot Cracking during Additive Manufacturing of Ni-base Superalloys

Background

Direct Metal Laser Sintering (DMLS) is one of the most adopted methods within the family of powder-bed additive manufacturing (AM) technologies. It has been recognized as a flexible and inherently materials efficient manufacturing technique that may serve as a potential candidate for production of gamma prime strengthened superalloy components such as those for aerospace engine applications. Aero engines operate under extreme service conditions which requires high material and process reliability with a minimal amount of material imperfections to meet critical requirements such as fatigue and fracture mechanical properties. However, the complex chemistry of highly alloyed Ni-base superalloys results in elemental segregation and phase transformations which together with a high amount of residual stresses during DMLS makes hot cracking a major obstacle for widespread production of aerospace components using DMLS. The complexity of the material-process system makes this problem intractable and further research is required to understand the possible scenarios affecting hot cracking during DMLS processing of Ni-base superalloys.

Description of the thesis work

The aim of this thesis work is to increase the knowledge regarding the metallurgical aspects of defect formation in gamma prime strengthened Ni-base superalloys during laser powder bed fusion. The aim is to investigate the effects of process parameters and powder feedstock characteristics on hot cracking and the possibilities of reducing cracking during DMLS. This is done by performing lab experiments using state of the art laser powder bed fusion equipment possessed by the department, followed by in-house characterization in our well-equipped characterization facilities.

Organization

Department of Industrial and Materials Science is hosting the competence centre “Centre for additive manufacturing – metal (CAM²)” that involves a broad network of national and international companies. This work will be focused on understanding the metallurgical phenomena and mechanisms responsible for crack formation during DMLS processing of γ’ precipitation hardened Nickel base superalloys.

The project will be done in collaboration between Siemens, EOS Finland Oy and IMS at Chalmers in the frame of CAM².


Qualifications: Interest and curiosity in the subject, good knowledge in material science, microstructure formation and phase transformations as well as good analytical skills. Experience in characterization techniques and processing knowledge are considered as advantages.

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