Intermetallic phases in 3D printed INCONEL 718

Corresponding author:

Dagmar Jandová, jandova@ntc.zcu.cz, University of West Bohemia, New Technologies - Research Centre

Abstract:

Microstructure of 3D printed INCONEL alloy consists of elongated austenitic grains with high density of precipitates. Three types of intermetallic phases, all with the Ni3X stoichiometry, were identified using transmission electron microscopy and energy dispersive X-ray microanalysis. Fine equiaxed gamma' and disc-shape gamma'' particles were spread within grains, while coarse plate-like delta phase pined grain boundaries. The metastable gamma', gamma'' phases and equilibrium delta phase can be represented as Ni3(Al,Ti) with the L12, Ni3(Nb,Al,Ti) with the DO22 and Ni3Nb with DOa unit cell respectively. The coherent gamma' and gamma'' phases nucleate independently of one another; Al and Ti atoms in solid solution promote gamma' precipitation, while Nb increases density of gamma'' phase. The incoherent delta phase forms at grain boundaries as a transformation product of gamma'' during 3D printing process and/or subsequent heat treatment. The both gamma' and gamma'' phases contribute to precipitation strengthening of the alloy. Delta phase stabilizes grain size and improve strength, however its uncontrolled growth can deteriorate stress rupture properties.

Key words:

Inconel 718, intermetallic phase, precipitation, TEM