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CHEMICAL COMPOSITION OF LAVES PHASE IN 718 INCONEL-TYPE LPBF ALLOY MODIFIED BY SURFACE LASER MELTING

In this work, the morphology and chemical composition of the Laves phase in the Ni-Fe-Cr super-alloy fabricated by the 3D-printing technology of the “Laser Powder Bed Fusion” is studied. The alloy contained 40.47 wt.% Ni, 14.34 wt.% Cr, 2.46 wt.% Mo, 2.10 wt.% Nb, 2.54 wt.% Ti, 0.44 wt.% Al, 0.18 wt.% W, 0.46 wt.% Mn, 0.40 wt.% Si, 0.12 wt.% V, 0.14 % Cu, 0.10 wt.% Co, with Fe as balance. The chemical composition of the alloy was close to that of Inconel 718-type, differing in the reduced contents of Ni, Cr and Nb. 3D-printed specimens were superficially modified through surface melting using a 400 W fiber laser with a scanning speed of 5 mm·s⁻¹. The investigations included scanning electron microscopy (SEM) observations (JSM-7000F JEOL), energy-dispersive X-ray spectroscopy (INCAx-sight, Oxford Instruments), X-ray diffraction (X’Pert PRO, PANalytical, Cu-K α radiation). The structure of the as-printed alloy consisted of a γ -phase (FCC) of cellular pattern, consisting of the “melt pools” left after the powder melting under the laser beam. After additional surface processing by the laser melting, the modified zone formed containing of columnar crystals and discontinuous eutectic network shown in Fig. 1a.

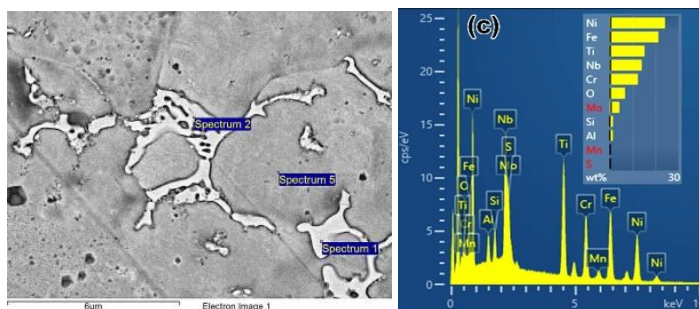


Figure 1. Eutectic inclusions of Laves phase in a laser modified zone (a). The EDX spectra of the Laves phase (b).

Using the point EDX (Fig. 1b) and XRD analyses it was found that the network features the complex-alloyed Laves phase $(\text{Ni,Fe,Cr,Mo})_2(\text{Nb,Ti,Si})$. The average chemical composition of the eutectic particles is (in wt.%): 5.05 ± 3.42 Si, 6.19 ± 0.76 Ti, 14.18 ± 2.18 Cr, 25.55 ± 2.71 Ni, 11.67 ± 1.12 Nb, 3.79 ± 2.18 Mo, 34.70 ± 7.59 Fe, 4.36 ± 2.1 O. The enrichment of eutectic phase with Ni, Nb and Cr was also confirmed by the EDX line-scanning (Fig. 2).

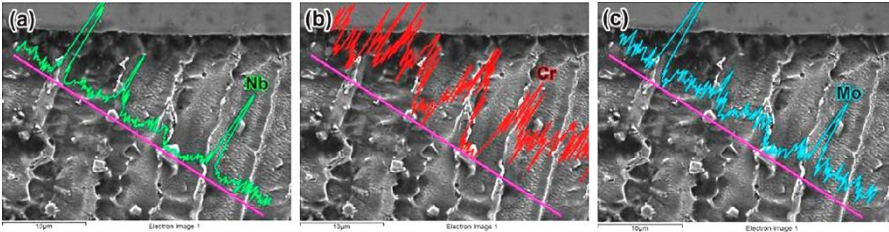


Figure 2. The line distribution of Nb (a), Cr (b) and Mo (c) withing the laser-modified layer.

The total distribution of chemical elements in the laser modified layer can be revealed from the EDX maps presented in Fig. 3.

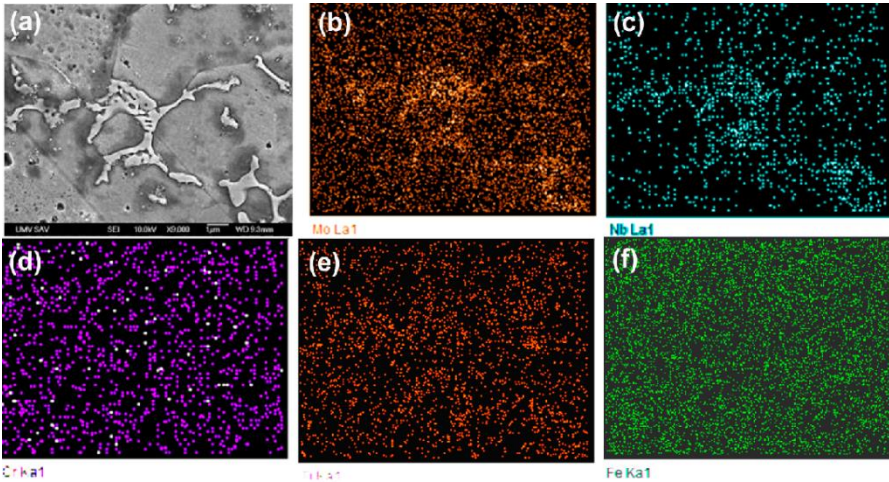


Figure 3. The SEM image of the microstructure (a). The EDX maps of the Mo (b), Nb (c), Cr (d), Ti (e) and Fe (f).

The characterization of the Laves phases (morphology, position, chemical composition) gives an important insight to the behavior of the alloy under mechanical, corrosion and tribocorrosion applications.