Additive manufacturing of complex-component alloys

Yong Liu
The State Key Laboratory of Powder Metallurgy
Central South University
Changsha 410083, P.R.China

Complex-component alloys (CCAs) with almost equal atomic ratios are a class of new metallic materials consisting of multi-elements. Compared with single-principal-element based conventional alloys, CCAs offer outstanding properties, for example, simultaneous high strength and high ductility, and high corrosion and wear resistance. This talk introduces our recent work on additive manufacturing of CCAs, and understanding of the relationship between microstructures and mechanical properties. Gas atomized CCAs powders were used for selective laser sintering (SLS). Fully dense and fine-microstructured FeCoCrNi-based CCAs can be conveniently fabricated by using SLS. The quality of CCAs is dependent on the SLS processing parameter. An increase of the SLS scanning power or a decrease of the scanning speed leads to an increase in the density of CCAs. The grain size decreased when the high scanning power or the low scanning speed was used. The carbon-doped CCAs with full density have a yield strength of 650 MPa, which nearly doubled that of the same alloy made by casting. The CCAs have unique cellular and columnar subgrain structures. The subgrain boundaries are composed of dislocation networks decorated by the segregation of Cr element and nanosized M23C6-type carbides, and thus, are the main strengthening factor for the C-containing CCAs The improvement of the mechanical properties of the CCAs is attributed to the solid solution strengthening, grain boundary strengthening and the homogenous microstructure, which increase the work hardening ability. SLS can be considered as a promising manufacturing route for the fabrication of large-sized and complex-shaped CCAs with high mechanical properties.