Heat Treatment for Additive Manufacturing

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Abstract

Additive manufacturing (AM) is getting growing interest thanks to the possibility to produce complex three-dimensional parts directly from CAD models. Steel and non ferrous alloys in the as-built condition typically show a finer solidification microstructure respect to the same parts produced by conventional routes. Mechanical properties are also very attractive, provided that the microstructure is modified by suitable heat treatment and finishing. As a matter of fact, the elimination of post-heat treatment still represents a tough challenge for AM, due to the poor homogeneity of the solidification structure (e.g. microsegregation, anisotropy…) and the possible formation of hard and brittle phases. The intrinsic heat treatment taking place during 3D printing is difficult to be controlled, also in view of the more and more demanding productivity required by the industry. In most cases, a suitable heat treatment is necessary to improve the microstructure produced by rapid solidification, optimize the properties, and recover internal stresses.

In this work, the influence of heat treatments on the properties of some selected steels and non ferrous alloys produced by Laser powder bed fusion (LPBF) and Direct Energy Deposition (DED) is considered. Mention will be made also to DED repair of tools and dies. The results show that microstructure and properties like hardness, hot strength, fracture toughness, and thermal fatigue resistance can be tuned after suitable heat treatment.