Abstract

Thanks to their admirable printability, AlSi10Mg and stainless steel 316L are among the alloys that have been repeatedly fabricated by different 3D printing technologies. In this research, some solutions for the development of these alloys through laser powder bed fusion (LPBF) have been examined. To compositional modification of these alloys, a wide range of alloying elements and non-metallic particles have been inoculated into the matrix through in-situ alloying and the effects of the added elements on the modification of the microstructure, on the mechanical properties and on the corrosion behavior of the studied alloys were investigated. To reduce the production cost of the additively manufactured steel, also the feasibility of replacing the gas atomized (GA) powders with water atomized (WA) powders was investigated. Furthermore, the impact of high-temperature rapid annealing of the LPBF fabricated SS316L for rapid stress-relieving the AM samples has been surveyed as a part of this research. According to the obtained results, the typical cellular structure of the additively manufactured alloys has an undeniable role in higher mechanical properties of the AMed parts compared to conventionally fabricated parts. During annealing, this cellular structure disappears before any grain evolution and results in a tangible drop in mechanical properties. Comparison of the fabricated components with GA and WA powders of SS316L revealed that by choosing the right process parameters and particle size distribution, WA samples would show higher mechanical properties, corrosion resistance and better surface roughness. Co-addition of the Ti and Mn to SS316L and Ni to AlSi10Mg by in-situ alloying revealed that activation of the slip systems in brittle phases and formation of the GNDs at matrix would preserve the interface of the particle/matrix from crack formation. Also, addition of the nanoparticles to AlSi10Mg revealed that stacking the nanoparticles on irregular shape particles would create some defects in AMed parts and degrade the mechanical properties.