Impact of Composition on the Heat Treatment Response of Additively Manufactured 17-4 PH Grade Stainless Steel

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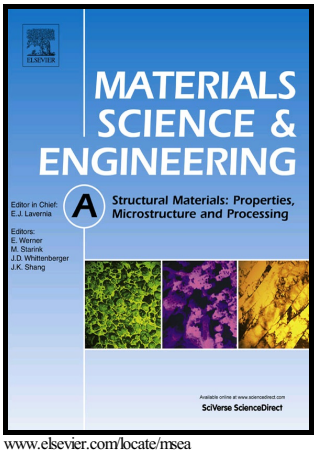

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Impact of Composition on the Heat Treatment Response of Additively Manufactured 17-4 PH Grade Stainless Steel

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Abstract

Precipitation hardened (PH) martensitic grade stainless steels are commonly used in additive manufacturing (AM) processes, but the heat treatment response can vary depending upon the powder feedstock composition. As-built AM 17-4 PH grade stainless steel fabricated using argon and nitrogen atomized feedstocks in separate powder bed fusion systems responded differently to standard heat treatment cycles. Materials fabricated from argon atomized feedstocks, containing low levels of nitrogen (0.01 wt.%) and retained austenite (<1%), responded as expected to standard solutionizing and aging heat treatment cycles. In contrast, materials fabricated from nitrogen atomized feedstocks, containing between 0.06 and 0.12 wt.% nitrogen and up to 81% retained austenite, did not display peak aging with standard heat treatments and deviated from the expected overaging response with increasing aging temperatures. At the highest nitrogen and retained austenite levels, peak aging is found to occur at temperatures in excess of 680°C, even though the material still contains retained austenite levels in the 20% range. These unexpected changes in the heat treat response are closely linked to differences in the nitrogen composition of the powder feedstock. Changes in the Ni and Cr equivalent values determined by other primary alloying elements also impact the heat treat response, even though the alloy compositions still fall within standard alloy element composition ranges.

Keywords: stainless steel; precipitation hardening (PH); additive manufacturing (AM); nitrogen; gas atomization; aging