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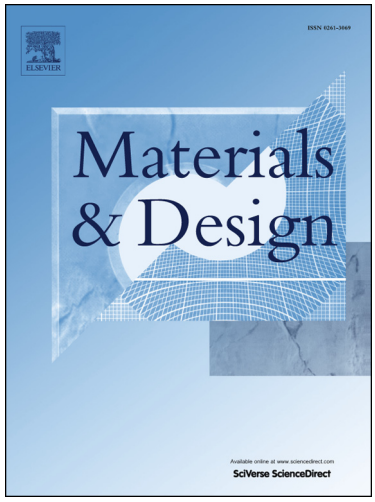

Effect of Retained Austenite on Subsequent Thermal Processing and Resultant Mechanical Properties of Selective Laser Melted 17-4 PH Stainless Steel

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Effect of Retained Austenite on Subsequent Thermal Processing and Resultant Mechanical Properties of Selective Laser Melted 17-4 PH Stainless Steel

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Abstract

Thermal processing and mechanical characterization of tensile specimens fabricated from bulk 17-4 PH material produced by selective laser melting (SLM) is presented. Prior to specimen evaluation, various industry standard and non-standard heat treatments were performed. The focus of this thermal processing was to evaluate the effect of aging on mechanical performance with or without a prior solution heat treatment. Volumetric fraction of metastable austenite was measured to vary with heat treatments performed and the initial conditions from which aging was initiated. Material aged following a solution heat treatment was found to have an austenite reversion from a fully martensitic structure to volumetric fractions as high as 20.4%. Whereas, initial concentrations of retained austenite in SLM as-fabricated material increased following a peak-age heat treatment, but decreased with higher temperature, overaged heat treatments. Specimens with large amounts of austenite demonstrated stress-induced transformation to martensite during tensile testing. This behavior was reflected in substantially reduced yield strengths, increased work hardening rates across greater ranges of strain, and delayed onset of localized plastic deformation. Ultimate tensile strengths for varieties of specimens aged to the peak-aged condition were similar, but differed greatly at strain levels where this strength was achieved.

Keywords: Additive Manufacturing; Heat Treatment; Stainless Steel; Selective Laser Melting; Retained Austenite

1. Introduction

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