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Microstructural Evolution of Maraging Steels from Powder Particles to Additively Manufactured Samples

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Abstract : In this research, 18Ni-300 maraging steel powder particles are investigated by studying particle size distribution along with their morphology and grain structure. The powder analysis shows mostly spherical morphologies with cellular structures. A laser-based additive manufacturing process, selective laser melting (SLM) is used to produce samples for further investigation of mechanical properties and microstructure. Several uniaxial tensile tests are performed on the as-built parts to evaluate the mechanical properties. The macroscopic properties, as well as microscopic studies, are then investigated on the printed parts. Hardness measurements, as well as porosity levels, are measured for each sample and are correlated with microstructures through electron microscopy techniques such as Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM). The grain structure is studied for the as-printed specimens and compared to the powder particle microstructure. The cellular structure of the printed samples is observed to have dendritic forms with dendrite width dimensions similar to the powder particle cells. The process parameter is changed, and the study is performed for different powder layer thickness, and the resultant mechanical properties and grain structure are shown to be similar. A phase study is conducted both on the powder and the printed samples using X-Ray Diffraction (XRD) techniques, and the austenite phase is observed to at first decrease due to the manufacturing process and again during the uniaxial tensile deformation. The martensitic structure is formed in the first stage based on the heating cycles of the manufacturing process and the remaining austenite is shown to be transformed to martensite due to different deformation mechanisms.

Keywords : additive manufacturing, maraging steel, mechanical properties, microstructure
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