Microstructure and Mechanical Property Heterogeneity in Directed Energy Deposition (DED) Austenitic Stainless Steel

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Localized melting, rapid cooling, and extensive thermal cycling occur during directed energy deposition (DED) processes and give rise to spatially varying thermal histories that affect local microstructures and mechanical properties in as-deposited materials. The homogeneity of microstructural features in as-deposited DED 304L was evaluated through electron backscattered diffraction, scanning electron microscopy, transmission electron microscopy, and electron probe microanalysis. Tensile properties were determined for three distinct combinations of build geometry and specimen orientation. Mechanical properties of the as-deposited DED 304L are comparable to conventional forged materials, with yield strengths ranging from 438-553 MPa and tensile elongations between 50-70%. By relating the spatial distribution of microstructural characteristics and mechanical properties, we show that heterogeneous fine-scale microstructures are responsible for differences in mechanical behavior.

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