

Title:

Investigation of Wire-Arc Directed Energy Deposition (DED) for Replacement of Conventionally Manufactured HY Steels

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Abstract:

Wire-arc DED provides a more cost and energy efficient solution for the fabrication of large-scale parts when compared to conventional manufacturing techniques. However, materials fabricated via wire-arc DED can have different properties due to cyclic heating occurring during the build. This study investigated the microstructure and mechanical properties of dense blocks from four different steel feedstock wire compositions (MIL-100S-1, ER120S-1, ER140S-1, and Fe-10Ni) and compared them to conventionally manufactured HY-80 and HY-100 parts. Characterization of the samples was conducted via thermodynamic modeling, optical microscopy, scanning electron microscopy, nanoindentation mapping, Vickers hardness testing, and profilometry-based indentation plastometry. MIL-100S-1, ER120S-1, and ER140S-1 phase fractions were successfully predicted using thermodynamic modeling and ER120S-1, ER140S-1, and Fe-10Ni all showed similar or superior hardness and mechanical performance when compared to wrought HY-80. The results indicate that wire-arc DED can be a useful replacement to conventional techniques for the manufacturing of HY steel parts.