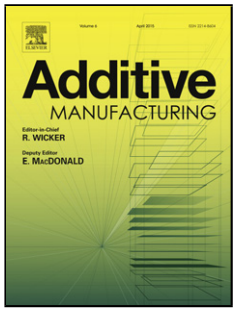

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Wire and Arc Additive Manufactured Steel: Tensile and Wear Properties

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Abstract: The present study systematically investigated the mechanical properties of wire-based (wire and arc additive manufacturing, known as WAAM) deposition of steel metals, both stainless steel 304 and mild steel ER70S. Graded material properties of stainless steel 304 were observed for wear and hardness in the direction of deposition and in Z height, due to variations in local thermal histories of the metal. Wear rates decreased significantly ($p = 5.6 \times 10^{-12}$ by one-way ANOVA) along the length of the deposited material, from $\mu = 2.62 \times 10^{-5}$ mm^3 / N · m and $\sigma = 2.32 \times 10^{-6}$ mm^3 / N · m, to $\mu = 0.63$ mm^3 / N · m and $\sigma = 3.08 \times 10^{-6}$ mm^3 / N · m, whereas microhardness values increased significantly ($p \sim 0$ by one-way ANOVA) along the same path from $\mu = 202.3$ HV and $\sigma = 5.82$ HV to 210.9 HV and $\sigma = 5.91$ HV. The yield and ultimate strength, however, were not found to be statistically significantly different ($p = 0.55$) along the direction of deposition for SS304. During wear testing, a grain refinement was observed directly beneath the wear scar in these materials in a focused ion beam channel observed under scanning electron microscopy. Additionally, no significant difference in yield strength was observed in printed mild steel (ER70S) between vertical and horizontal specimens. The observed graded