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The potentials of using directed energy deposition (DED) to process a cold work tool steel for repairing purposes

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Additive manufacturing (AM) using Directed Energy Deposition (DED) has emerged as a potential technique for repairing components of high-performance materials like K340 tool steel. K340 is a high-carbon, chromium-molybdenum-vanadium alloyed cold-work tool steel known for its exceptional mechanical properties, making it ideal for demanding applications such as forming and stamping tools and dies. This study explores the feasibility of using the DED process to repair K340 tool steel components. Initially, by depositing different double-tracks, process parameters such as laser power, gas flow rate, and travel speed were systematically varied and optimized to achieve optimum deposition dimensional accuracy, minimal porosity, desired penetration, and a proper surface quality. Cubic samples were then deposited on a platform made from the same material. Microstructural analysis, by using optical microscopy and scanning electron microscopy, revealed that the rapid solidification inherent to the DED process results in a fine cellular and dendritic structure with retained austenite and segregation of the alloying elements in inter dendritic regions in the as-built condition. Post-processing heat treatments were employed to homogenize the microstructure and improve hardness by transforming retained austenite into martensite, thereby enhancing the mechanical properties and wear resistance of the material. Mechanical testing showed that the hardness values of DED-processed K340 steel could be significantly improved after heat treatment, reaching up to 830 HV, comparable to conventionally produced materials. The results demonstrate that the DED process is a viable approach for processing K340 tool steel, offering tailored microstructures and mechanical properties through process optimization and subsequent heat treatments. This research provides valuable insights into the potential of DED for repairing high-performance tooling materials, reducing lead times, and minimizing material wastage, and paving the way for broader industrial adoption in the manufacturing sector.

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