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Maximizing Sustainability in Additive Manufacturing: A Comprehensive Study on CX Steel Powder Reusability via LPBF

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Metal powders used in additive manufacturing (AM) are expensive and energy-intensive to manufacture desired engineering parts. Reusing these powders reduces material waste, lowers production costs, and minimizes the environmental footprint of AM processes to support sustainable manufacturing routes. Therefore, this study investigates the reusability/degradation of CX steel powders via laser powder bed fusion (LPBF) through the employment of multiple powder handling strategies and in/ex-situ process monitoring. The impact of powder handling and reusing strategies, up to a total of 50 builds, are assessed based on the microstructure and mechanical properties of LPBF-built components. Microstructural analysis is conducted to evaluate the evolution of powder morphology throughout manufacturing cycles. Mechanical properties, assessed using hardness, tensile and impact toughness tests, are meticulously examined to determine any potential degradation due to powder reuse. The findings demonstrate that while the powder morphology undergoes a transformation upon completion of each build slightly, the LPBF-built CX steel exhibits negligible alterations in its mechanical properties after post-process heat treatments. This remarkable outcome is attributed to the effectiveness of the implemented powder handling strategies, which mitigate potential detrimental effects associated with powder recycling. These observations signify the viability of reusing CX steel powders in LPBF without compromising the structural integrity of LPBF-built parts. This paves the way for significant advancements in sustainability efforts within the domain of AM by reducing waste generation and minimizing the environmental impact of the LPBF process.

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