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Tribological Behavior Of 17-4PH Steel Produced Via Binder Jetting And Low Energy High Current Pulsed Electron Beam Surface Treated

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Abstract : Additive manufacturing of stainless steels is rapidly developing thanks to the ability to achieve complex designs effortlessly. Stainless steel 17-4PH is valued for its high strength and corrosion resistance, however intricate geometries are challenging to obtain due to rapid tool wear when machined. Binder jetting additive manufacturing was used to produce 17–4PH samples and pulsed electron beam surface treatment was investigated to enhance surface properties of components. The aim is to improve the tribological performance compared to the as-sintered condition and the H900 aging process, which optimizes hardness and wear resistance. Printed samples were sintered in a reducing atmosphere and superficially treated with an electron beam by varying the voltage (20 - 25 - 30 kV) and pulse count (20 – 40 pulses). Then, the surface was characterized from a microstructural and mechanical standpoint. Scratch tests were performed, and a reciprocating linear pin-on-disk wear test was conducted at 2 N and 10 Hz. Results showed that the voltage affects the roughness and thickness of the treated layer, whilst the number of pulses influences the hardening of the microstructure and consequently the wear resistance. Treated samples exhibited lower coefficients of friction compared to as-printed surfaces, though the values approached those of aged samples after the abrasion of the melted layer, indicating a deeper heat-affected zone formation. Different amounts of residual stress in the heat effected zone were individuated through the scratch tests. Still, the friction remained lower than that of as-printed specimens. This study demonstrates that optimizing electron beam parameters is vital for achieving surface performance comparable to bulk aging treatments, with significant implications for long-term wear resistance.

Keywords : low energy high current pulsed electron beam, tribology, binder jetting 3D printing, 17-4PH stainless steel
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