A feasibility study on Plasma Electrolytic Polishing of Additively Manufactured Metal Parts

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Additive manufacturing (AM) of metal parts is gaining traction in various industries due to its ability to produce complex geometries with greater design flexibility, shorter lead times and minimal material loss. However, one of the biggest challenges of AM, especially for metal components, is the high surface roughness of the manufactured parts, which requires effective post-processing to meet the stringent surface quality requirements for practical applications. Plasma electrolytic polishing (PEP) has proven to be a promising post-processing technique that enables efficient surface enhancement without compromising material integrity. This study investigates the optimization of PEP, both as a stand-alone process and in combination with particle blasting, to improve the surface quality of additively manufactured stainless steel samples. In addition, the feasibility of applying PEP to multi-material structures, specifically Functional Graded Materials (FGMs) produced by Directed Energy Deposition (DED), focusing on materials comprising a cast iron base, an Inconel intermediate layer and a top layer of maraging steel, is investigated. For stainless steel AM samples, the combination of 10 minutes particle blasting, and 3 minutes PEP resulted in a 70% reduction in surface roughness. For the FGM samples, PEP resulted in good surface quality on the upper maraging steel layers; however, undesirable material removal was observed in the intermediate Inconel layer, indicating the need for further optimization of electrolyte composition and process parameters. These results suggest that refinement of PEP could unlock its full potential for FGM samples and wider applications.

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