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Application of metal additive manufacturing material extrusion in the production of tool inserts for polymer profile extrusion die surface roughness investigation

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Abstract

The ever increasing availability of different metal additive manufacturing (AM) technologies, enhanced process capabilities, and material variations results in an expanding area of application. With different AM variants challenging usability, timeline and costs, application tests of technological variants within certain manufacturing setups is of interest to determine new applications and developments of existing processes. In the current work, material extrusion based metal AM is investigated for the production of tool inserts for polymer profile extrusion. For this particular manufacturing process, the surface topography is of large interest as the internal surface roughness contributes toward the final external surface of the extrudate product. Conventionally manufactured benchmark inserts were compared to AM inserts. The internal surface roughness of inserts were evaluated using silicone replicate technology. The conventionally manufactured insert had a surface roughness of Sa_{conv} = 374nm compared to a $Sa_{metalAM}$ = 5854nm for the AM insert. Extrusion of ABS was performed for each of the two inserts using water-cooling and constant extrusion process parameters. The subsequent surface roughness of the extrudates products were found to be $Sa_{convExtrudate}$ = 248nm and $Sa_{metalAMExtrudate}$ = 512nm respectively. This gives an indication that despite the high surface roughness of the AM insert, the influence on the final extrudates product is limited. However, additional post processing of the internal surface may provide a further reduction of the resulting extrudates surface roughness. In this work, successful testing and comparison of a conventionally manufactured tool insert and a metal AM tool insert has been performed, making it possible to determine the correlation between internal die surface roughness and resulting external extrudates surface roughness along with application feasibility of extrusion based metal AM for tooling on polymer profile extrusion. Future work will include an elaborate investigation of the correlation of internal die and external extrudates surface roughness.

Metal Additive Manufacturing, Tooling, Material Extrusion, Fused Filament Fabrication, Profile Extrusion, Surface Roughness