Optimization of the 3D freeforming process of PIM feedstock in granular form

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This work describes the development of a hybrid material optimized for processing by two different technologies: powder injection molding (PIM) and 3D extrusion. The aim is to design and optimize the 3D extrusion parameters of a PIM-grade feedstock in order to produce printed parts with acceptable surface roughness prior to sintering. The feedstock consisted of iron carbonyl metal powder combined with an environmentally friendly wax-based binder. The critical solid loading was determined by torque analysis during compounding in a twin-screw mixer. To ensure the material's suitability for both injection molding and 3D printing, its flow behavior was analyzed using a capillary rheometer, which enabled the identification of appropriate processing parameters for both manufacturing methods.

Based on these parameters, test sets of samples were prepared by 3D extrusion as well as by conventional injection molding. The surface quality and morphology of the parts before sintering were evaluated using microscopic analysis, allowing a detailed comparison of both production methods. The results were further analyzed using advanced statistical tools to quantify differences in surface characteristics and to define the technological limitations and potential of the hybrid approach. This work contributes to a deeper understanding of the relationships between feedstock composition, flow behavior, and the resulting quality of pre-sintered parts produced by both additive and conventional technologies.

Keywords: powder injection molding, 3D freeforming, feedstock, hybrid material, surface roughness.

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