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AN INNOVATIVE DEVICE TO ANALYZE HEAT TRANSFERS IN SELECTIVE INFRARED SINTERING (SIS) AND TO IMPROVE MODELLING OF THE PROCESS

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Selective Infrared Sintering (SIS) is a new additive manufacturing process. It is based on the irradiation of selected areas of a polymer powder layer by an infrared source, in order to melt and fuse the particles. The SIS process starts by spreading a thin layer (from 75µm to 200µm) of powder, preheated in the powder supply tank, over the previous layer in the build tank. Then, a mask, i.e. the negative image of the section to be sintered, is placed above the surface. The area delimited by the mask is then irradiated from the infrared source. In this manner, the irradiated powder particles are (partially or totally) melted. Coalescence, sintering, densification occur during the heating process, followed by consolidation and crystallisation upon cooling. This cycle is repeated until the 3D part is complete. In this work, we propose an original approach, both experimental and numerical, of this process. To our knowledge, it is the first fundamental investigation of heat transfers in polymer additive manufacturing processes. We designed and built a new lab-scale IR-sintering machine in the purpose of monitoring the complex thermal behaviour of the polymer powder and parts in a “part build tank”. It should allow to a better understanding of the temperature evolution undergone by the sintered part. A composite powder (PA12 mixed with carbon black as an IR absorber) was used in this study. DSC measurements were performed, and the crystallization kinetics was modelled after identifying all the crystallization parameters needed. A 1D numerical model, simulating the heat transfers (heat conduction and IR radiation), coalescence, densification and then crystallization will be proposed. Comparison with experimental temperature measurements will be presented and all the coupled multiphysics phenomena will be discussed in order to propose recommendations for the process optimization.