Numerical and Experimental Analysis of the Thermal Profile of Printed Layers During Selective Laser Sintering Process of Poly(etheretherketone)

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Abstract. Selective laser sintering (SLS) is a process of additive manufacturing (AM) based on the melting and adhesion of thermoplastic powder. The family of polyaryletherketone (PAEK) are the most durable in severe environment among high performance thermoplastics. Polyetheretherketone, known as PEEK, is the most used in this family. Despite noteworthy progress to master its processing, printing PEEK parts remains a challenge because of high melting temperature (345°C) and fast crystallization on cooling. More knowledge about the thermal transfer during SLS process would open the way to extend uses of SLS process. A combined experimental-numerical approach was carried out to estimate the influence of each thermal cycle on the chemical structure and the mechanical properties of each layers during SLS process.

This study points out the evolution of the temperature of a layer [i] as a function of the number of layers below it. In particular, it was determined from which layer [i+n], the laser has no effect on the layer [i]. The thermal profile was obtained on the basis of the solution into conduction phenomena through the material using finite element method (FEM). Abaqus© software was used for calculations. Laser beam heat sources were described by a Gaussian distribution of heat source power intensity, constant over entire surface, with material penetration deep. The calculations were optimized by considering the laser displacement with DFlux subroutine. The printing parameters dependent on laser and heat flux input were applied in FEM. As a result, the thermal history of each layer [i] has been calculated. Our simulation shows that the heating due to the laser path spans length scales equivalent to 14 deposited layers.