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DIRECT MANUFACTURING OF THERMOPLASTIC PARTS BY POWDER LASER SINTERING: COMPARISON OF COALESCENCE SIMULATIONS AND FRENKEL BASED PHYSICAL MODEL

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Polymer parts obtained by direct manufacturing with laser sintering technology present a porosity which significantly reduces their mechanical resistance. This po-rosity is due to the air between polymer powder grains which remains locked in the material while polymer is melting. The physical mechanism hidden behind this process is the coalescence of liquid polymer particles. As the process is anisotherm, air volume evolutions have to be taken in account, influencing directly the density of the material. The evolution of coalescence of two liquid spheres can be described by analytic models. It is driven by surface tension, while viscosity, geometry, gravity and temperature change the kinetics of the process. A coalescence simulation, implemented in Matlab, has been implemented on the base of an incompressible perfect fluid including surface tension effect. Gravity, surface tension, air compressibility and viscosity are taken in account in a C-NEM simulation performed to calculate the ve-locity of all the nodes in the domain. Particular work is made to discretize as well as possible the interface between air and polymer. Mesh is indeed adapted to the local curvature of the interface. We present a comparison between a 2D (infinite cylinders) numerical simulation of coalescence phenomenon, analytical models (2D & 3D) and experiments per-formed on polymer fibers (2D) and polymer grains (3D). Experiments are done on hotplates under microscope. The first results let see that the simulated coalescence is faster than the analytic one. It could be explained by the two strong hypotheses in analytical solutions, one on the strain field, and the other one on the grain shape which is supposed to remain circular. Then the influence of grain size is discussed from the comparison between experiments and simulations