Computational modelling of the Selective Laser Sintering process for viscoelastic particles

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ABSTRACT

Selective Laser Sintering is a promising 3D printing technique, where products are built of polymer powder on a layer-by-layer basis. The method gives geometrical freedom to the designer and enables the production of objects that are impossible to make using conventional techniques. To optimize the fabrication method, we assess the process in detail.

We constructed a computational model using the finite element method to solve the flow problem of the sintering of two viscoelastic particles. We assume the particles to be liquid, spherical and initially connected. The flow is incompressible and isothermal. Inertia and body forces can be neglected. The interface is modelled as a sharp interface with constant surface tension. The movement of the interface is determined using an interface tracking method. We use DEVSS-G [1-3], SUPG [4] and log-conformation approach [5] for numerical stability. The deformation of the mesh is monitored and remeshing is performed to assure accurate solutions. For the Newtonian limiting case, Hopper's analytical solution [6] is used to validate the model.

The problem is solved for different values of the Deborah number, defined as the ratio of the fluid response time scale to the process time scale. With increasing Deborah number, the contact radius increases faster during the first time steps, but the system takes longer to equilibrate. We compare the stresses in the neck region for different Deborah numbers and they appear to be a combined action of the elastic stresses, solvent stresses and surface tension. This shows the complexity of the problem.

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