Simulation of the direct ink write process using finite elements and cThruAMR

Direct ink write (DIW) is an additive manufacturing technique that enables the creation of complex geometries for many technologies by depositing an “ink” material onto a substrate in a particular pattern, often through a syringe. The inks used in DIW often have complicated rheological properties and thus presents many challenges for computational models. These include rheology that shear thins and has a yield stress as well as the need to capture the location of the free surface as it evolves over time. Here, we will simulate the DIW process using the Galerkin finite-element method (GFEM) to solve the equations of motion using a non-Newtonian viscosity. To track the ink/air/substrate interface we use Conformal Transient h-r Unstructured Adaptive Mesh Refinements (cThruAMR), which is new, novel method for tracking material interfaces while maintaining high-quality elements connected to the interface surfaces. This formulation eases application of boundary conditions such a capillarity or temperature jumps between phases since there are mesh lines on the interface. In this talk we will perform a validation of this DIW model by comparing to several experimental configurations and ink materials. In addition, we will present the results of both two- and three-dimensional simulations of the DIW process, observing various flow features and other physical phenomena for several printing patterns and ink formulations. *SNL is managed and operated by NTESS under DOE NNSA contract DE-NA0003525*