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Modelling Polymer Deformation during 3D Printing CLAIRE MCILROY, PETER OLMSTED, Georgetown University — Three-dimensional printing has the potential to transform manufacturing processes, yet improving the strength of printed parts, to equal that of traditionally-manufactured parts, remains an underlying issue. The fused deposition modelling technique involves melting a thermoplastic, followed by layer-by-layer extrusion to fabricate an object. The key to ensuring strength at the weld between layers is successful inter-diffusion. However, prior to welding, both the extrusion process and the cooling temperature profile can significantly deform the polymer micro-structure and, consequently, how well the polymers are able to "re-entangle" across the weld. In particular, polymer alignment in the flow can cause de-bonding of the layers and create defects. We have developed a simple model of the non-isothermal extrusion process to explore the effects that typical printing conditions and material rheology have on the conformation of a polymer melt. In particular, we incorporate both stretch and orientation using the Rolie-Poly constitutive equation to examine the melt structure as it flows through the nozzle, the subsequent alignment with the build plate and the resulting deformation due to the fixed nozzle height, which is typically less than the nozzle radius.

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