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Modelling Polymer Deformation and Welding Behaviour during 3D Printing[1] CLAIRE MCILROY, PETER OLMSTED, Georgetown University — 3D 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 most common method, fused deposition modelling, involves melting a thermoplastic, followed by layer-by-layer extrusion of the material to fabricate a three-dimensional object. The key to the ensuring strength at the weld between these layers is successful inter-diffusion. However, as the printed layer cools towards the glass transition temperature, the time available for diffusion is limited. In addition, the extrusion process significantly deforms the polymer micro-structure prior to welding and consequently affects how the polymers "re-entangle" across the weld. We have developed a simple model of the non-isothermal printing process to explore the effects that typical printing conditions and amorphous polymer rheology have on the ultimate weld structure. In particular, we incorporate both the stretch and orientation of the polymer using the Rolie-Poly constitutive equation to examine how the melt flows through the nozzle and is deposited onto the build plate. We then address how this deformation relaxes and contributes to the thickness and structure of the weld.

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