Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

Interdiffusion of Polycarbonate in Fused Deposition Modeling Welds JONATHAN SEPPALA, AARON FORSTER, SUSHIL SATIJA, RONALD JONES, KALMAN MIGLER, NIST - Natl Inst of Stds & Tech — Fused deposition modeling (FDM), a now common and inexpensive additive manufacturing method, produces 3D objects by extruding molten polymer layer-by-layer. Compared to traditional polymer processing methods (injection, vacuum, and blow molding), FDM parts have inferior mechanical properties, surface finish, and dimensional stability. From a polymer processing point of view the polymer-polymer weld between each layer limits the mechanical strength of the final part. Unlike traditional processing methods, where the polymer is uniformly melted and entangled, FDM welds are typically weaker due to the short time available for polymer interdiffusion and entanglement. To emulate the FDM process thin film bilayers of polycarbonate/d-polycarbonate were annealed using scaled times and temperatures accessible in FDM. Shift factors from Time-Temperature Superposition, measured by small amplitude oscillatory shear, were used to calculate reasonable annealing times (min) at temperatures below the actual extrusion temperature. The extent of interdiffusion was then measured using neutron reflectivity. Analogous specimens were prepared to characterize the mechanical properties. FDM build parameters were then related to interdiffusion between welded layers and mechanical properties. Understating the relationship between build parameters, interdiffusion, and mechanical strength will allow FDM users to print stronger parts in an intelligent manner rather than using trial-and-error and build parameter lock-in.

Jonathan Seppala
NIST - Natl Inst of Stds & Tech

Date submitted: 14 Nov 2014 Electronic form version 1.4