Evolution of entanglements in crazing of glassy polymers

ROBERT S. HOY, MARK O. ROBBINS, Johns Hopkins University Department of Physics and Astronomy — Highly entangled polymer glasses often fail via crazing [1]. The polymer expands by a large factor $\lambda$ from an initial dense state to a craze network of fibrils and voids. The value of $\lambda$ is found to correlate with the chemical distance between entanglements in both experiments [1] and simulations [2], indicating that the entanglements act like chemical bonds in limiting the expansion. We have applied the primitive path analysis method developed by Everaers et. al. [3] to follow the real space structure of entanglements in model polymer glasses during crazing. A wide range of initial states corresponding to melts with different Kuhn lengths and entanglement lengths was studied. In each case the primitive paths deform affinely and the number of entanglements remains constant during craze formation. Straining the craze past $\lambda$ leads to a gradual reduction in the number of entanglements, and ultimately to craze fracture.