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Why is the tube model inapplicable for entangled polymer dynamics at large deformation SHI-QING WANG, YANGYANG WANG, University of Akron — Accumulating experimental revelation of the phenomenology governing dynamics of entangled linear polymers at large deformations has caused us to question the legitimacy of the tube model as an acceptable theoretical description of nonlinear polymer rheology. Upon an explicit investigation of its premise, we have come to realize that the tube model did not overcome the difficulty confronted by other theories and did not contain the basic physics required to explain why and how the entanglement network must break down during large deformations. It considered an unrealistic situation where a load-bearing chain relaxed fast in an affinely deformed tube so that only the chain segment orientation produced the shear stress for applied rates lower than the Rouse rate. A non-monotonic relation between the resulting shear stress and imposed strain for startup shear and step deformations arose from excessive chain orientation not collapse of the entanglement network. In the tube model, the nature of the overshoot is not yielding (transition from elastic deformation to flow), but an elastic instability. Accumulating experimental observations contradict this picture. This presentation will elucidate how the emerging physical picture differs from that of the unrealistic tube model.

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