Nonlinear Elasticity of Entangled Polymer Networks
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Carolina at Chapel Hill — We develop a microscopic model for elastic-
ty of entangled polymer networks. The classical models of rubber
elasticity (affine network and phantom network models) take into ac-
tount only the effect of cross-links, but not the entanglements between
polymer chains. For uniaxial deformation, the entanglement effects can
be characterized by the dependence of Mooney ratio on network de-
formation. Constrained network models (such as constrained-junction
and diffused-constraint models), tube models (such as Edwards’ tube
and nonaffine tube models) as well as phenomenological models (such as
Mooney- Rivlin model) have been proposed to capture the experimen-
tally observed dependence of Mooney ratio on network deformation. One
of the latest efforts in the field is the slip-tube model, in which the entan-
glements are represented by slip-rings that can glide along the network
chains but elastically constrained in space. The model we study improves
over the original slip-tube model by taking into account harmonic in-
teractions along the chain between such slip-links. We analytically and
numerically solve the new microscopic model and present our results in
comparisons with experimental and simulation data for both uniaxial
and biaxial deformation.

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