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A Gaussian Slip-Link Model for Polymer Single and Double Networks JAY D. SCHIEBER, Professor, MAHNAZ ESKANDARI, Ph.D. student, HAMID ARASTOOPOUR, Professor — In this study, we developed Schieber's slip-link model for lightly cross-linked polymers assuming the equilibration of deformed Gaussian chains. Our simulation consists of two steps: preparation and deformation. In the preparation step, cross-links and slip-links are assumed to be distributed randomly along the chain, but with independent statistical parameters: the average number of Kuhn steps between entanglements, N_e, and the average number of Kuhn steps between cross-links, N_c. In the second step, the cross-links and slip-links are deformed affinely, but since the chain can slide through the slip-links, its deformation is non-affine. The stress tensor can be determined as a function of deformation using Brownian dynamics as a sort of Monte Carlo algorithm. The Mooney plot of our simulation result has good agreement with most experimental data for uniaxial elongation deformation for cross-linked NR, PDMS, and PBd. The model is used to predict values for the Mooney plot parameters (C_1 and C_2) as a function of N_e and the N_c/N_e ratio. The C_2/C_1 ratio is found to be strongly dependent on N_c/N_e, but weakly dependent on N_e. This observation provides a new way of predicting the cross-link density and separating it from the entanglement density and for systems of known N_e and N_c, the model requires no adjustable parameters. We are also developing our model for double network polymers in order to demonstrate different applications for the model.

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