Abstract Submitted
for the MAR10 Meeting of
The American Physical Society

How Entangled Polymer Chains Relax RICHARD WOOL, Department of Chemical Engineering, Univ Delaware — It will be shown through a series of experiments with selectively deuterated model polymers that stress relaxation occurs through a mechanical percolation process which permits large clusters of entangled polymers to stress relax before their conformations are fully relaxed. We find that: (a) Reptating homopolymer chains with molecular weight M >> M_c appear to be non-Reptating as their ends and centers relax at the same rate in a Rouse-like manner during percolation. (b) The mechanical relaxation time $.\tau$(M) is related to the Reptation time $T_r \sim M^3$ by $.\tau(M) = T_r[(1\text{-}M_c/M)\ M_e/M_c]^2$, which is the origin of the viscosity behaving as $.\eta \sim M^{3.4}$ (c) During stress relaxation, the random coil dimensions $R_g(//)$ and $R_g(.\perp)$ are significantly not relaxed when the stress and birefringence relax to zero. (d) Matrix molecular weight P effects on relaxation time $.\tau$(M) of the probe chain M are as follows: When the probe chain M>>P, the matrix P-chains percolate and Rouse-like dynamics is observed for the M-Reptating chains with $.\tau(M) \sim P^1M^2$. (e) When the matrix P>>M, percolation does not occur for the M-chain and the relaxation time of the probe chain $.\tau(M) \sim P^oM^3$ is in accord with DeGennes Reptation theory. These results clearly suggest that current notions of polymer rheology involving chain end fluctuation and constraint release need to be reconsidered. .

Richard Wool
Department of Chemical Engineering, Univ Delaware

Date submitted: 27 Nov 2009 Electronic form version 1.4