Abstract Submitted
for the MAR06 Meeting of
The American Physical Society

Adhesion at Entangled Polymer Interfaces: A Unified Approach..

RICHARD WOOL, Univeristy of Delaware — A unified theory of fracture of polymer interfaces was developed which was based on the Rigidity Percolation model of fracture [R.P. Wool, J.Polym.Sci. Part A: Polym Phys., 43,168(2005)]. The polymer fractured critically when the normalized entanglement density p, approached the percolation threshold p_c. The fracture energy was found to be $G_{1c} \sim [p\text{-}p_c]$. When applied to interfaces of width X, containing an areal density Σ of chains, each contributing L chain entanglements, the percolation term $p \sim \Sigma L/X$ and the percolation threshold was related to Σ_c, L_c, or X_c. For welding of A/A symmetric interfaces, $p = \Sigma L/X$, and $p_c \approx L_c/M \approx 0$, such that when $\Sigma/X \sim 1/M$ for randomly distributed chain ends, $p \sim L \sim (t/M)^{1/2}$, $G/G^* = (t/\tau^*)^{1/2}$, where the weld time $\tau^* \sim M$. When the chain ends are segregated to the surface, Σ is constant with time and $G/G^* = [t/\tau^*]^{1/4}$. For sub-T_g welding, there exists a surface mobile layer (due to the critical Lindemann Atom fraction) of depth $X \sim 1/\Delta T^{\nu}$ such that $G \sim \Delta T^{-2\nu}$, where the critical exponent $\nu = 0.8$. For incompatible A/B interfaces of Helfand width d, normalized width $w = d/R_{ge}$, and entanglement density $N_{ent} \sim d/L_e$, $p \sim d$ such that, $G_{1c} \sim [d\text{-}d_c]$, $G_{1c} \sim [w\text{-}1]$, and $G \sim [N_{ent}\text{-}N_c]$. For incompatible A/B interfaces reinforced by an areal density Σ of compatibilizer chains, L and X are constant, $p \sim \Sigma$, $p_c \sim \Sigma_c$, such that $G_{1c} \sim [\Sigma - \Sigma_c]$, which is in excellent agreement with experimental data.

Richard Wool
Univeristy of Delaware

Date submitted: 03 Dec 2005 Electronic form version 1.4