MS 133 Kinetic Processes in Materials

Assignment #2.1

Due: Friday, May 20, 2016

Please do each problem on a separate page/set of pages.

Please work clearly and explain what you are doing. Partial credit will be given for incomplete solutions and/or for stating your approach to a problem even if you cannot complete it.

Credit will be given for evaluating your results and their significance.

#1. Interdiffusion experiments in polymers can be performed by preparing two films and placing them in contact at time t=0, then monitoring the position of the interface between them by tracking fine tracer particles (e.g., gold) that were deposited on the surface of the film before the two were brought together. Consider the case of flexible amorphous polymers. Let the molecular weights of the chains in the top and bottom films be denoted M_t and M_b. When $M_t = M_b$ the boundary is observed not to move, in accordance with the symmetry of the physical situation. When $M_t \neq M_b$, the boundary moves in the direction of the lower molecular weight chains. Explain. How is the time-dependent displacement of the interface related to M_t and M_b?

#2. Read pp. 188-196 (attached; first part of Chapter 6 of *The Theory of Polymer Dynamics* by M. Doi and S. F. Edwards). Derive the expression given in eq. (6.12), and explain in your own words its physical meaning and how it leads to the result in eq. (6.16). The latter can be tested by a simple stress relaxation experiment, since the decay of the orientation correlation is manifested in the decay of the stress following a sudden deformation.

#3. Read the article by Tom Russell, Richard Wool, Jimmy Mays and their coworkers "Direct Observation of Reptation at Polymer Interfaces", *Nature*, vol 365, pp. 235-237 (1993). Explain the concept of their experiment using your own words and figures. Do not carry out the analysis, but describe the governing equations that must be solved to predict the transient concentration profile of the labeled segments with time when the two types of labeled chains they describe are allowed to interdiffuse. Feel free to refer to subsequent articles on the subject of "ripples", but be sure to cite your sources if you use material from other articles or books.

Handout: Doi & Edwards, *The Theory of Polymer Dynamics,* Chapter 6.

Reference Tom Russell, Richard Wool, Jimmy Mays, et al., "Direct Observation of Reptation at Polymer Interfaces," *Nature*, vol 365, pp. 235-237 (1993).