The Web Course on the Physical Properties of Glass

Homework Set #3- part 1

Please return to Richard Brow (brow@mst.edu) by Friday, September 26th. Note that a second set of problems will be assigned based on our discussion of glass transition behavior.

1. Calculate the rate of rise of spherical bubbles of different sizes (from 10 microns to 1 cm) in a molten glass tank, glass density 2.5 g/cm^3 and a viscosity of 10^2 P. How long will it take bubbles of different sizes to rise 100 cm under these conditions? Note: see Prof. Varshneya's chapter on viscosity for relevant discussion.

2. Consider a soda-lime silicate glass fiber in a Littleton softening point experiment. The surface tension of the glass in a dry atmosphere is 300 mN/m and the measured Littleton softening point is 750ºC. When the fiber is equilibrated in a wet atmosphere, the surface tension is reduced to 200 mN/m. By how much does the apparent Littleton softening temperature change? Note: see Prof. Varshneya's chapter on viscosity for relevant discussion.

3. Review the 1995 Science article by Angell, then describe and explain in detail the relationship between the change in heat capacity at T_g and the fragility characteristics of the corresponding melt viscosities. On the Angell 'fragility plot' why do all normalized viscosity curves converge at an apparent viscosity of ~10^{-4} P as $T_g/T \rightarrow 0$?

4. From your review of the literature, identify a family of glasses (or representative compositions) that possess glass thermal expansion coefficients in the range 125-175x10^{-7}/ºC and glass transition temperatures below 450ºC. Such glasses could be used for seals to a variety of metals. What are the advantages or disadvantages for using your compositions for such applications? Note: You might use GoogleScholar, the SciGlass database, or similar electronic resources for your literature review.