

Homework 9
Polymer Physics 2024
Due Tuesday March 12 at noon

(**pdf** file should be called: **HW 4 Group x Last Name _Name _Name _Name.pdf**)

Ultra-high molecular weight polyethylene (UHMWPE) is used in situations where high wear resistance is needed in rotational molded parts such as truck bed liners, coal shoots, and hip implant cups. It can also be gel spun in the non-entangled state to make high strength fibers for bullet proof vests and racing sails. Chaudhuri K, Lele AK *Rheological quantification of the extent of dissolution of ultrahigh molecular weight polyethylene in melt-compounded blends with high density polyethylene* J. Rheo. **64** 5113705 (2020) discuss the use of low UHMWPE fractions in blends with HDPE (high-density polyethylene) to enhance modulus through high intensity shear mixing of disentangled UHMWPE.

- a) Mixing in polymer science is classified as dispersive or distributive. Explain the difference between these types of mixing, which is prevalent in laminar flow such as in narrow tubes with high viscosity, and which is prevalent in turbulent flow, large tubes, low viscosity, high flow rates. Which of these types of mixing occur in the “high shear” mixer used by Chaudhuri? Which mixing is preferable for Chaudhuri’s work? Use the Reynold’s number and the Deborah number in your answer and discuss the problem with mixing extremely high viscosity UHMEPE with HDPE of lower viscosity. (UHMWPE and HDPE will have drastically different De and Re at a given shear rate.)
- b) Equation 7 gives the time dependent relaxation modulus for blends of UHMWPE and HDPE. Explain how this equation is used to fit frequency data shown in figures 5 and 6. Why is the molecular weight distribution needed to fit the blend SAOS data? What is the Cox-Merz rule.
- c) The intrinsic viscosity in Figure 8 has a power-law dependence on molecular weight of 0.7. How would you interpret this?
- d) Explain how the composition of the dPE/HDPE blend is determined. Give a sequenc of steps used by Chaudhuri.
- e) Figure 9 shows that the fraction of the loaded dPE that dissolves in HDPE decreases with increasing loading fraction of dPE. Why might this be the case? Remember that these two materials are nominally miscible at all concentrations.