

Homework 12
Polymer Physics 2023

Due Tuesday April 11 at noon

(Please send one email with a **pdf** attachment to beaucag@uc.edu)

The file should be called: **HW 8 Group x Last Name_Name_Name_Name.pdf**)

Foglia F, Frick B, Nania M, Livingston AG, Cabral JT *Multimodal confined water dynamics in reverse osmosis polyamide membranes* Nature Comm. **13**, 2809 (2022) discuss a study to determine the various relaxation times and transport of water and polyamide in an interfacially polymerized osmosis membrane using QENS from backscatter (BS) and time of flight (TOF). They resolve complex dynamics for water transport that includes a “jump-diffusion mode” which could be important to understanding the design of polyamide reverse osmosis membranes for water purification.

- a) “Our hypothesis is that water diffusion through the network (or “bulk” polymer matrix) and aggregate “pores” can be experimentally resolved with a judicious choice of complementary instrumental resolutions. Other physical pictures can, however, also be conceived, for instance in terms of interfacial and bulk water diffusion, subdiffusive dynamics within the dense polymeric membrane, and possible spatio-temporal coupling with multiscale relaxation processes within the polymer network.” Explain each of the four possible models for water diffusion in polyamide membranes mentioned by Foglia.
- b) https://www.ill.eu/sites/BS-review/Elastic_files/Elastic.html describes a fixed window scan. Explain Foglia’s Figure 1. Explain “Diffusive and local (e.g., rotational) motions can be discriminated by the Q -dependence or -independence, respectively, of the characteristic maximum. Significantly, these results demonstrate that data from PA membranes hydrated with H_2O yield information from H_2O diffusion, while those from PA hydrated with D_2O isolate the polymer dynamics in the hydrated state, permitting their decoupling in the scattering data.”
- c) Explain equations 2 and 3. How are LA and SA motions decoupled?
- d) Explain the “jump-diffusion model” for water transport and why it might be useful to describe water diffusion in a polyamide membrane.
- e) The curves for the translational diffusion coefficient for bulk water and for water in the hydrated membrane as a function of $1/T$ cross. Explain why this occurs.