Supporting Material for

Transition to the viscoelastic regime in the thinning of polymer solutions

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March 12, 2022

Influence of the flow rate on the thinning dynamics

To ensure that the thinning of the polymer solutions is not influenced by the flow rate set by the syringe pump, the pinch-off experiments were carried out at different flow rates. We show an example in figure 1 for the thinning of a 4000K PEO of concentration $c = 0.5\%$ in a 75/25 wt% water/glycerol. The flow rates used are $Q = 0.01$, 0.02, 0.05, 0.1, and 0.2 mL/min. We observe that the thinning dynamics at those different flow rates collapse on the same master curve, thus ensuring that in this range of flow rate, the thinning occurs in a quasi-static regime.

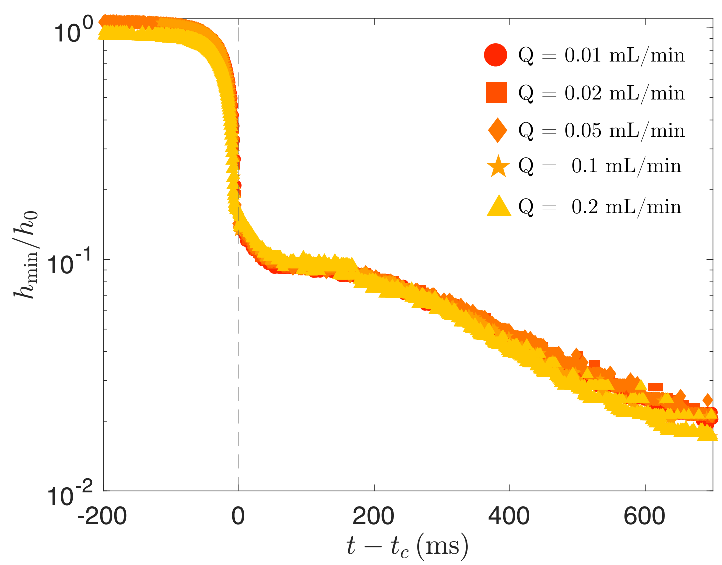

Figure 1: Thinning dynamics of polymer solutions of 4000K PEO with $c = 0.5\%$ in a 75/25 wt% water/glycerol solvent. The flow rates varies from $Q = 0.01$ to 0.2 mL/min.

Influence of the frame rate on the critical strain rate

For the experiments involving the 4000K PEO in 75/25 wt% water/glycerol solvent, the frame rates were varied from 500 fps to 10000 fps depending on the concentration of polymer to account for the large range of relaxation times λ_R obtained. For example, we estimated the influence of the frame rate from 5000 fps to 50000 fps for the 4000K PEO at $c = 0.005\%$ in 75/25 wt% water-glycerol solvent to ensure that the frame rate does not influence the measurement of $\dot{\varepsilon}_\mathrm{c}$ obtained at the transition. The concentration $c = 0.005\%$ was considered since this concentration led to the shortest relaxation time for this molecular weight. We also consistently increased the size of the window over which $\dot{\varepsilon}_\mathrm{c}$ was averaged with the frame rate. The mean strain rates over different frame rates is $\dot{\varepsilon}_\mathrm{c} = 1.1\,\mathrm{ms}^{-1}$ with less than 5% deviation around this value.

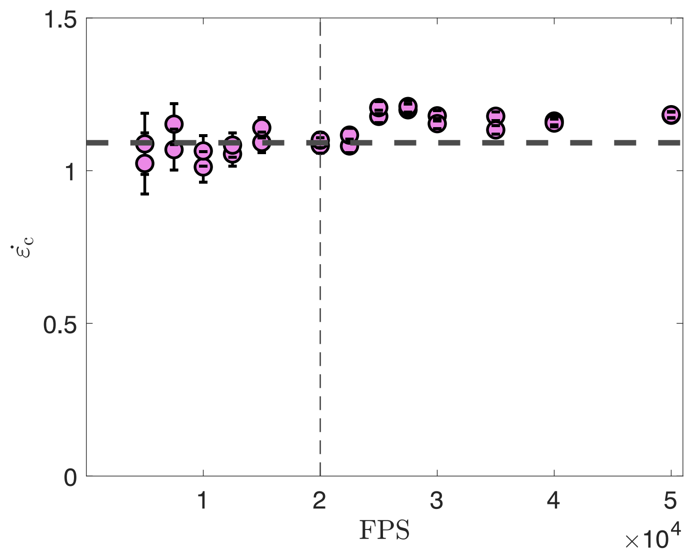

Figure 2: Evolution of $\dot{\varepsilon}_\mathrm{c}$ obtained experimentally when varying the frame rate per second (fps) for 4000K PEO at $c = 0.005\%$ in a 75/25 wt% water-glycerol solvent.

Rheology of 300K and 4000K PEO in 75/25 wt% water-glycerol solvent

We measured the shear viscosity η of the solution of 300K and 4000K PEO in a 75/25 wt% water-glycerol solvent. We measured the viscosity of each solution using a rheometer (Anton Paar MCR 92) with a 50 mm-wide 1^{o} cone-plate geometry. For the 300K PEO, the shear viscosity remains constant with the shear rate $\dot{\gamma}$ for $c = 0.01\%$ to 0.5%, and shows a weak shear-thinning at $c = 1\%$. The 4000K PEO the shear viscosity remains nearly constant between $c = 0.005\%$ and 0.02%, and then a shear-thinning is observed for $c = 0.05\%$ to 1%.

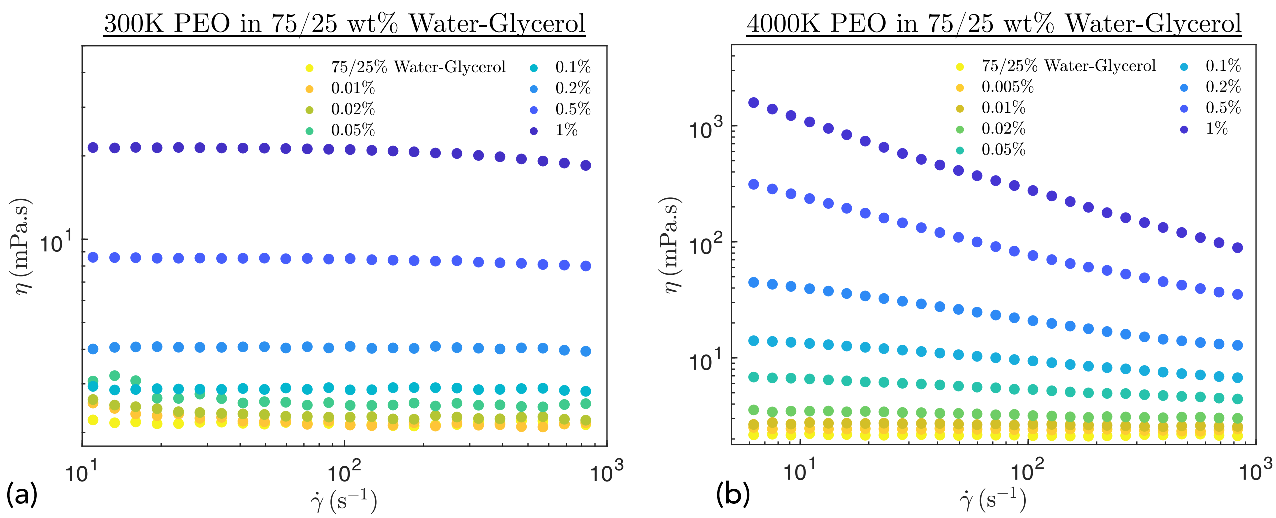

Figure 3: Evolution of the shear viscosity η with the shear rate $\dot{\gamma}$ for polymer solutions prepared with different mass concentrations of (a) 300K PEO and (b) 4000K PEO in a 75/25 wt% water-glycerol solvent.

Influence of the nozzle diameter on the thinning dynamics and the strain rate

To elucidate the influence of weight of the drop on the thinning and the pinch-off, we considered nozzles of different diameters $h_0 = 0.4$, 0.9, 1.6, and 2.75 mm. Here, we show the results for the 300K PEO at $c = 0.5\%$ in a 75/25 wt% water-glycerol solvent. The corresponding thinning $h(t)$ and $\dot{\varepsilon}(t)$ are shown in figures 4(a) and 4(b), respectively.

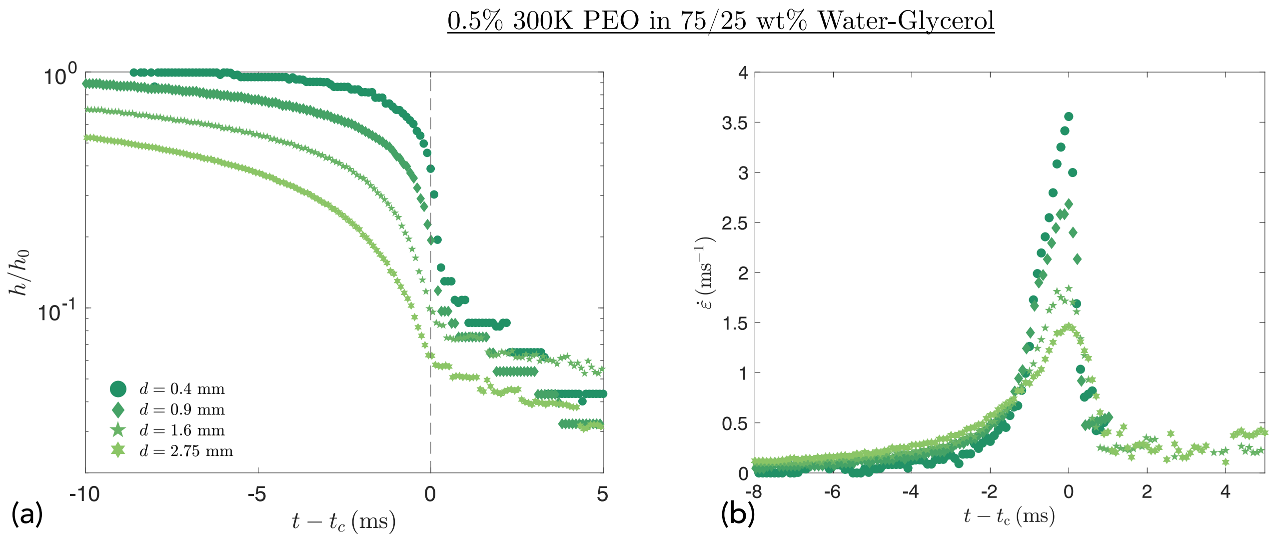

Figure 4: (a) Thinning dynamics $h(t)/h_0$ and (b) evolution of the strain rate $\dot{\varepsilon}(t)$ of a 300K PEO solution at $c = 0.5\%$ in 75/25 wt% water-glycerol solvent for different nozzle diameters $h_0 = 0.4, 0.9, 1.6 \,\&\, 2.75\,mm$.

Movies of the experiments.

- Movie corresponding to the pinch-off of a droplet of 50/50 wt% Water-Glycerol solvent at 10000 fps, shown in figure 1(a) and used in figures 3(a)-3(b) in the main manuscript.
- Movie corresponding to the pinch-off of a droplet of $c = 0.5\%$ 300K PEO in a 75/25 wt% Water-Glycerol Solvent at 10000 fps, shown in figure 1(b) in the main manuscript.
- Movie corresponding to the pinch-off of a droplet of $c = 0.5\%$ 300K PEO in 50/50 wt% Water-Glycerol Solvent at 10000 fps, used for the data shown in figures 3(a)-3(b) in the main manuscript.