Supplementary Information

Ionic strength and polyelectrolyte molecular weight effects on floc formation and growth in Taylor-Couette flows

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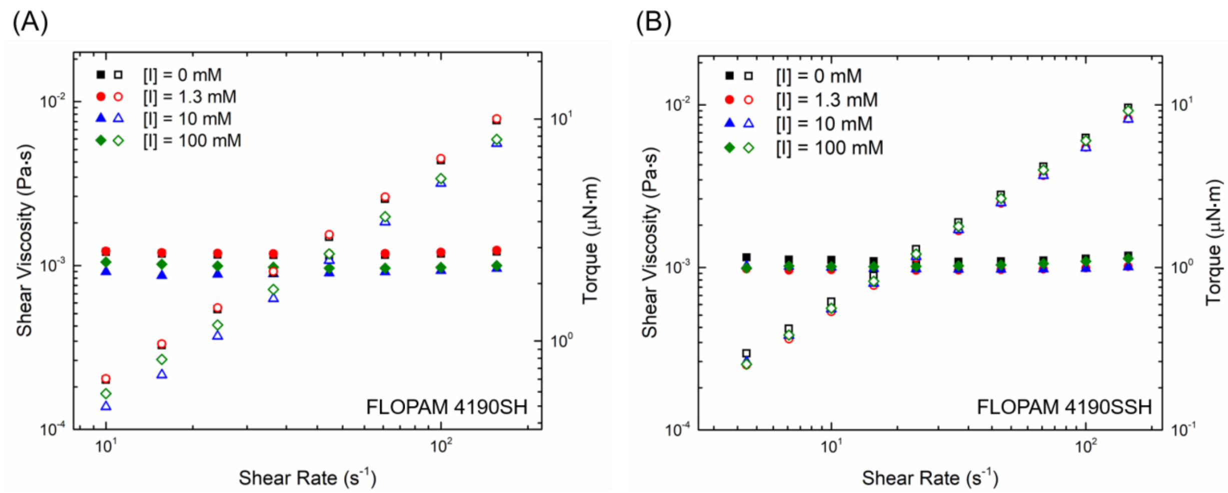

Figure S1: Steady shear viscosity (closed symbols) and torque response traces (open symbols) as a function of solution ionic strength with shear rate for the (A) lower molecular weight cationic polyacrylamide flocculant (4190SH) and the (B) higher molecular weight cationic polyacrylamide flocculant (4190SSH). The temperature was kept constant at 23ºC. The experiment was performed using the cup and bob geometry to mimic the Taylor-Couette cell geometry.

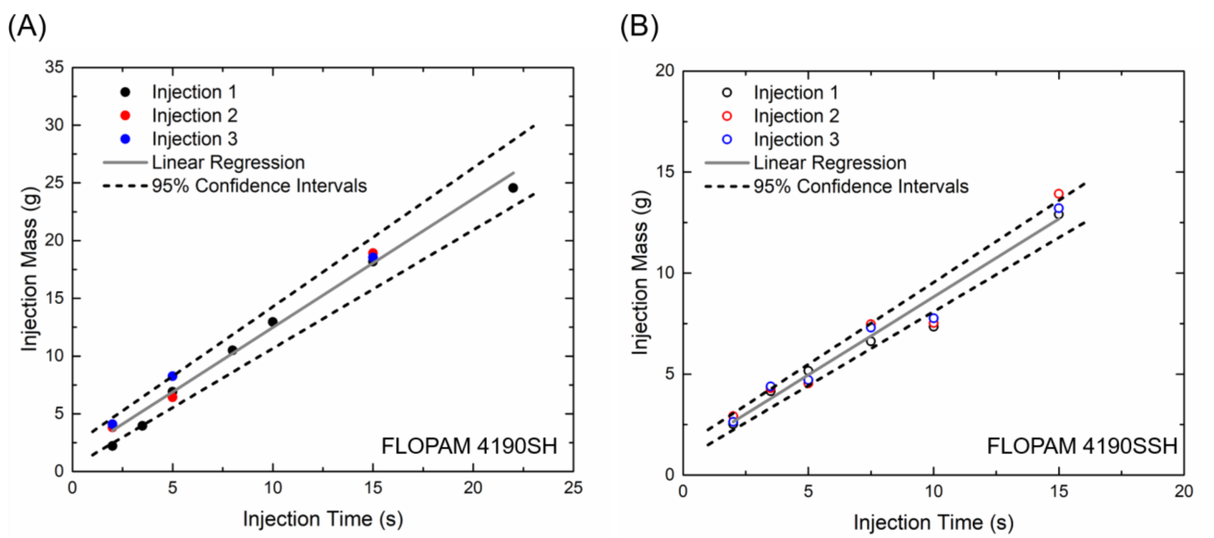

Figure S2: Flow rate calibration curves for polyelectrolyte injection from the inner cylinder of the TC cell at a drive pressure of 30 psi. The closed symbols represent the (A) lower molecular weight cationic polyacrylamide flocculant (4190SH) while the closed symbols represent the (B) higher molecular weight cationic polyacrylamide flocculant (4190SSH). The solid gray line represents a linear regression of the data points while the dashed black lines represent upper and lower 95% confidence intervals. The slope of the linear regression is the flow rate in g s^{-1} that was used to calculate the drive time needed to inject the required mass of polyelectrolyte into the annulus to obtain the required concentration shown in Table 1. The linear fit equations are (A) Injection Mass = (1.115 ± 0.089)∗Injection Time + (1.330 ± 0.922), $R^2 = 0.99$ and (B) Injection Mass = (0.772 ± 0.039)∗Injection Time + (1.098 ± 0.330), $R^2 = 0.96$.

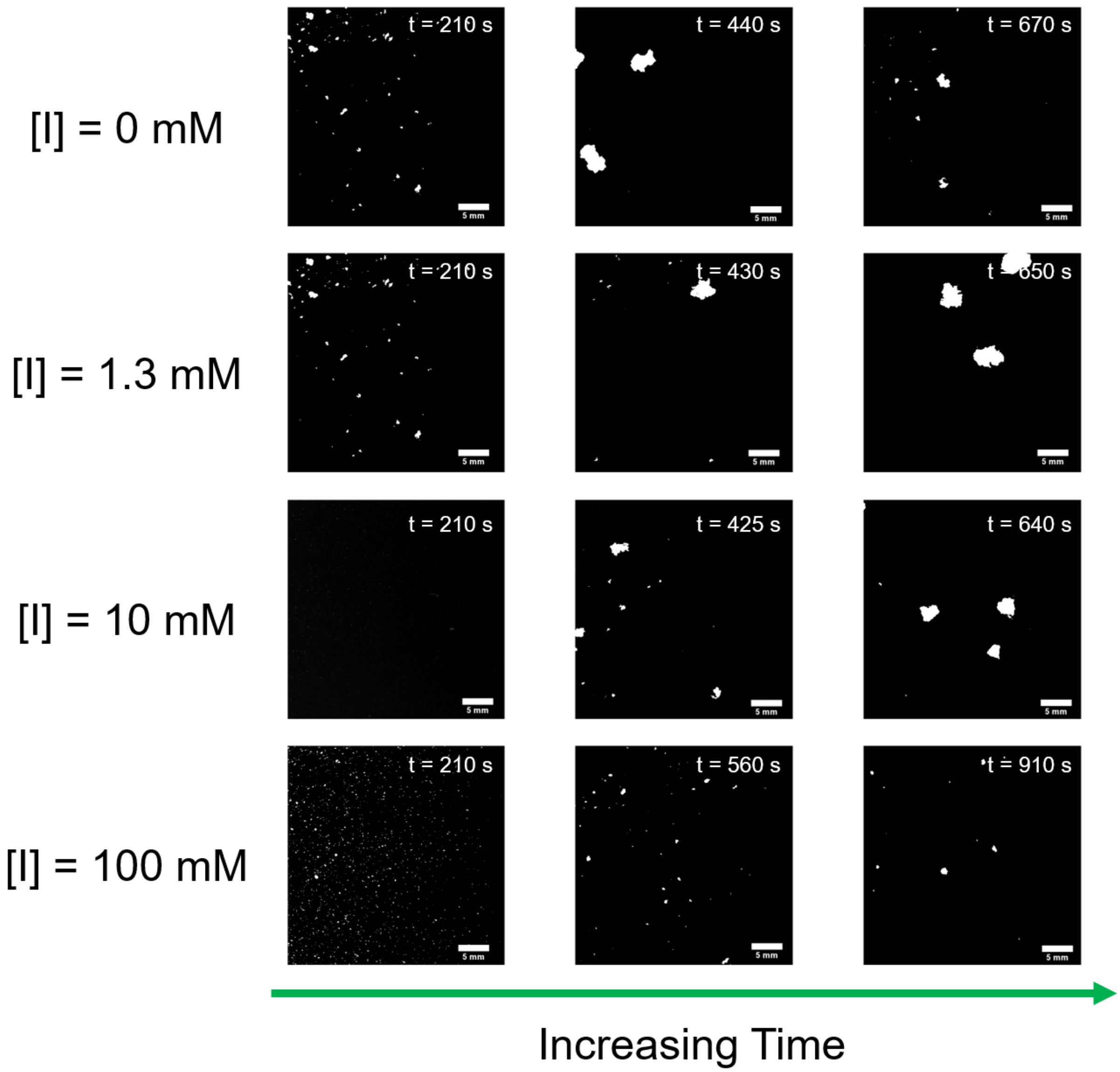

Figure S3: Time lapse of binarized images of bentonite-cationic polyacrylamide flocs (here, the 4190SSH flocculant was used) as a function of ionic strength. The first image in each row is at 210 s, which is the onset of the inner cylinder speed change from Stage 1 to Stage 2 mixing. The last image in each row occurs where the floc size plateaus. The middle image in each row occurs at the midpoint time between the times associated with the first and last images. The white scale bar in the lower right-hand corner of each image represents 5 mm. The movie frames have been resized to comply with figure dimension limitations. The actual movie frames used in the quantitative analysis are larger than what is shown here (actual dimensions of each frame are 1280 × 1024 pixels).

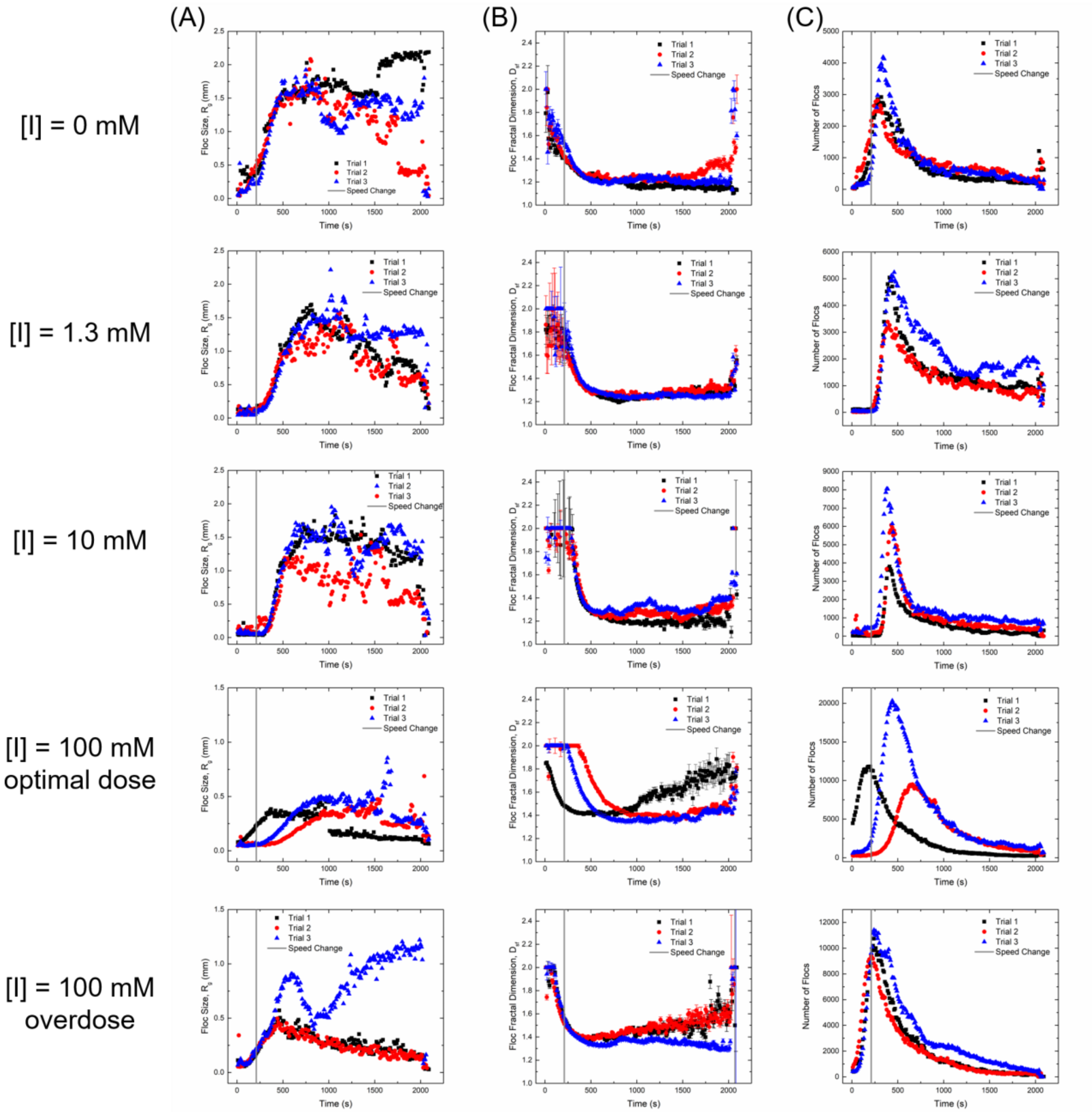

Figure S4: All trials for the (A) floc sizes expressed as radius of gyration, R_g, (B) 2-D floc fractal dimension, and (C) number of flocs as a function of ionic strength with time for the lower molecular weight cationic polyacrylamide flocculant (4190SH). The vertical gray line depicts where the inner cylinder speed transitions from $\Omega_i = 0.5\ s^{-1}$ to $\Omega_i = 0.46\ s^{-1}$.

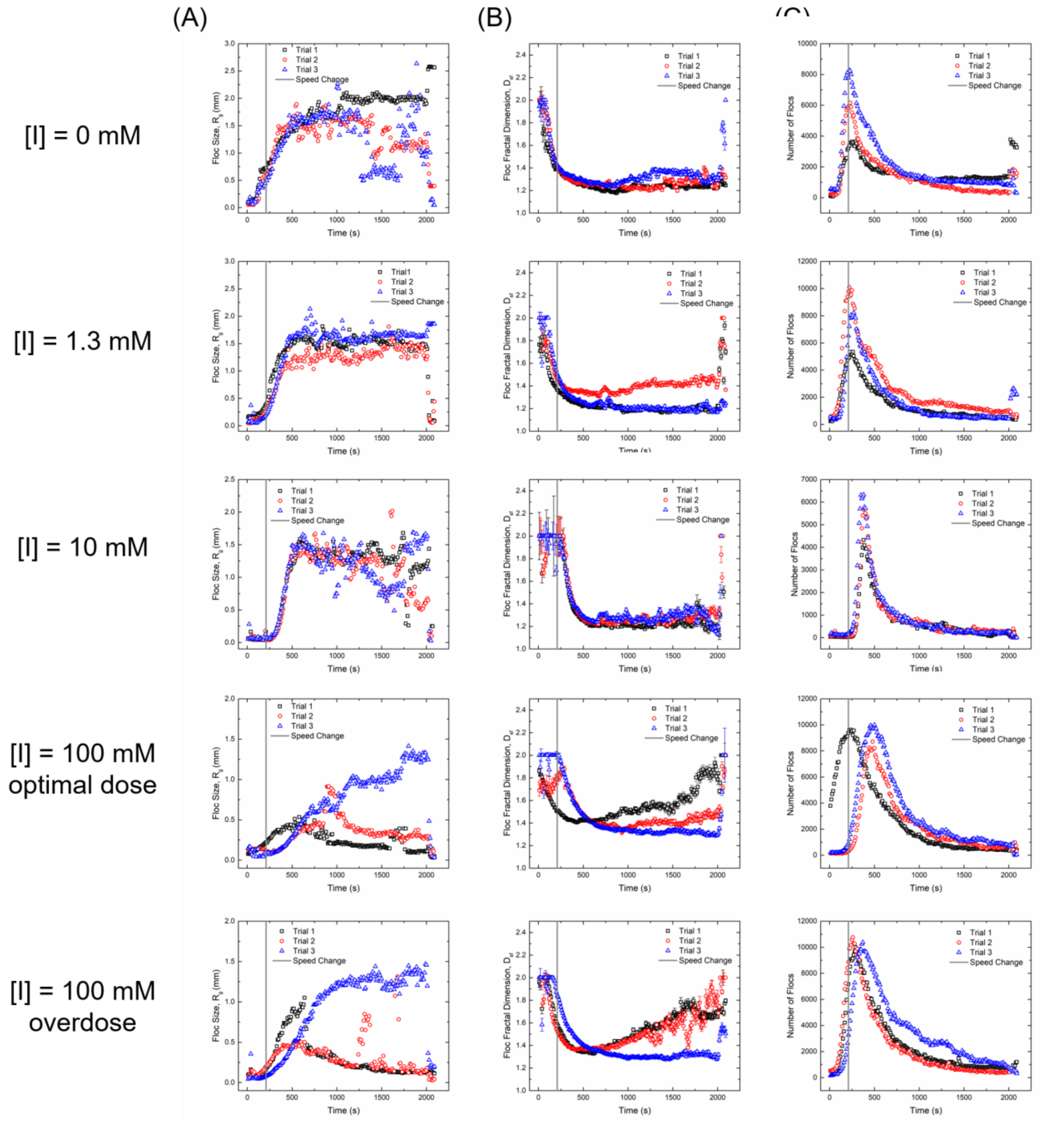

Figure S5: All trials for the (A) floc sizes expressed as radius of gyration, R_g, (B) 2-D floc fractal dimension, and (C) number of flocs as a function of ionic strength with time for the lower molecular weight cationic polyacrylamide flocculant (4190SSH). The vertical gray line depicts where the inner cylinder speed transitions from $\Omega_i = 0.5\ s^{-1}$ to $\Omega_i = 0.46\ s^{-1}$.

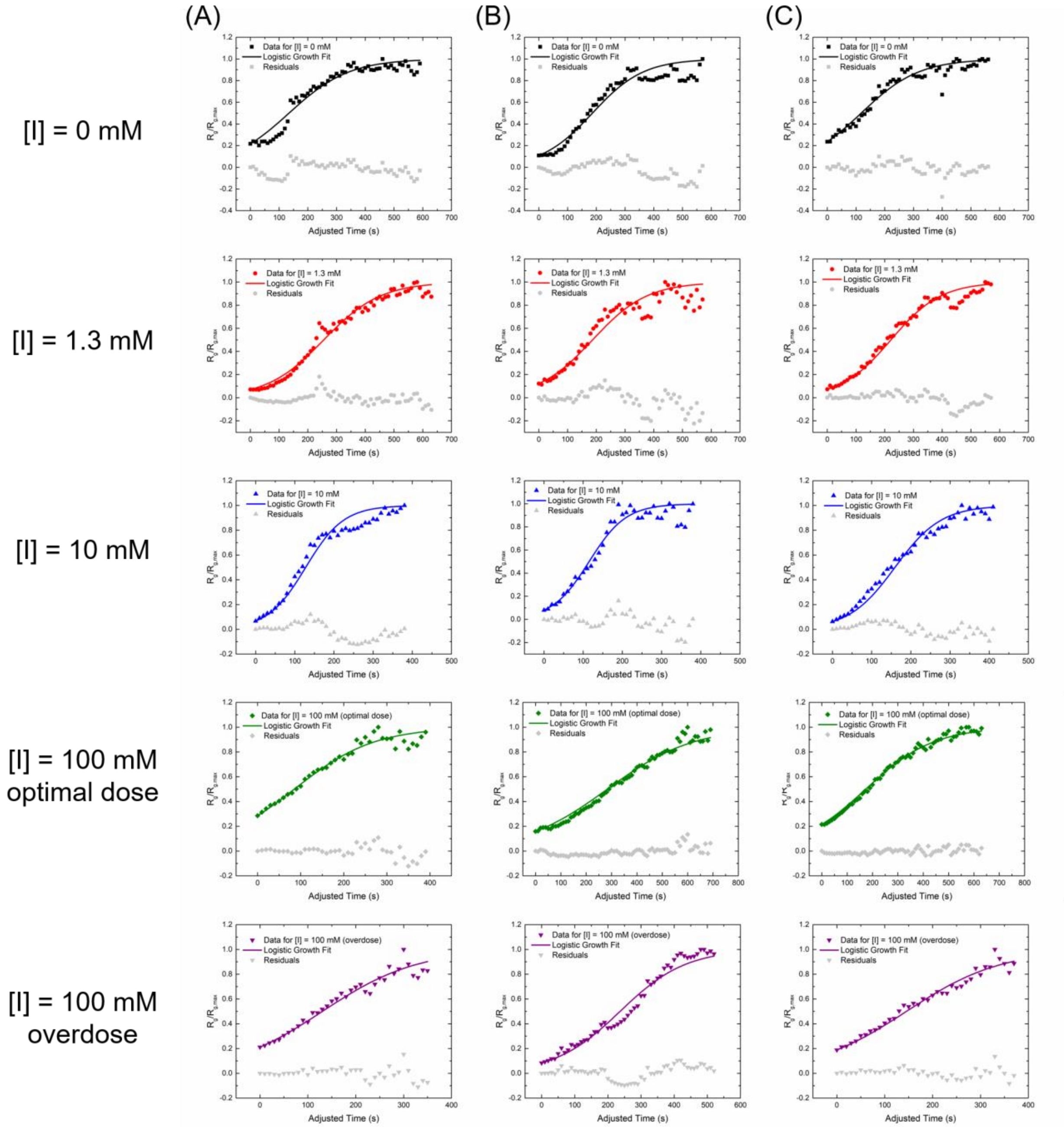

Figure S6: Logistic growth fits to floc size data over time for (A) trial 1, (B) trial 2, and (C) trial 3. The fits here are for the solutions containing the lower molecular weight polyelectrolyte (4190SH) at all solution ionic strengths tested in this study. For each plot, the closed, colored circles represent the R_g data points collected during the experiment normalized by the maximum value of R_g in the fitting range, which is where the floc size plateaus. The solid, colored line indicates the logistic growth fit. The closed gray circles represent the residuals of the fit, which is the data point calculated using the logistic growth model subtracted from the original data at each corresponding time point. The time was adjusted such that the beginning of floc growth occurs at time = 0 s.

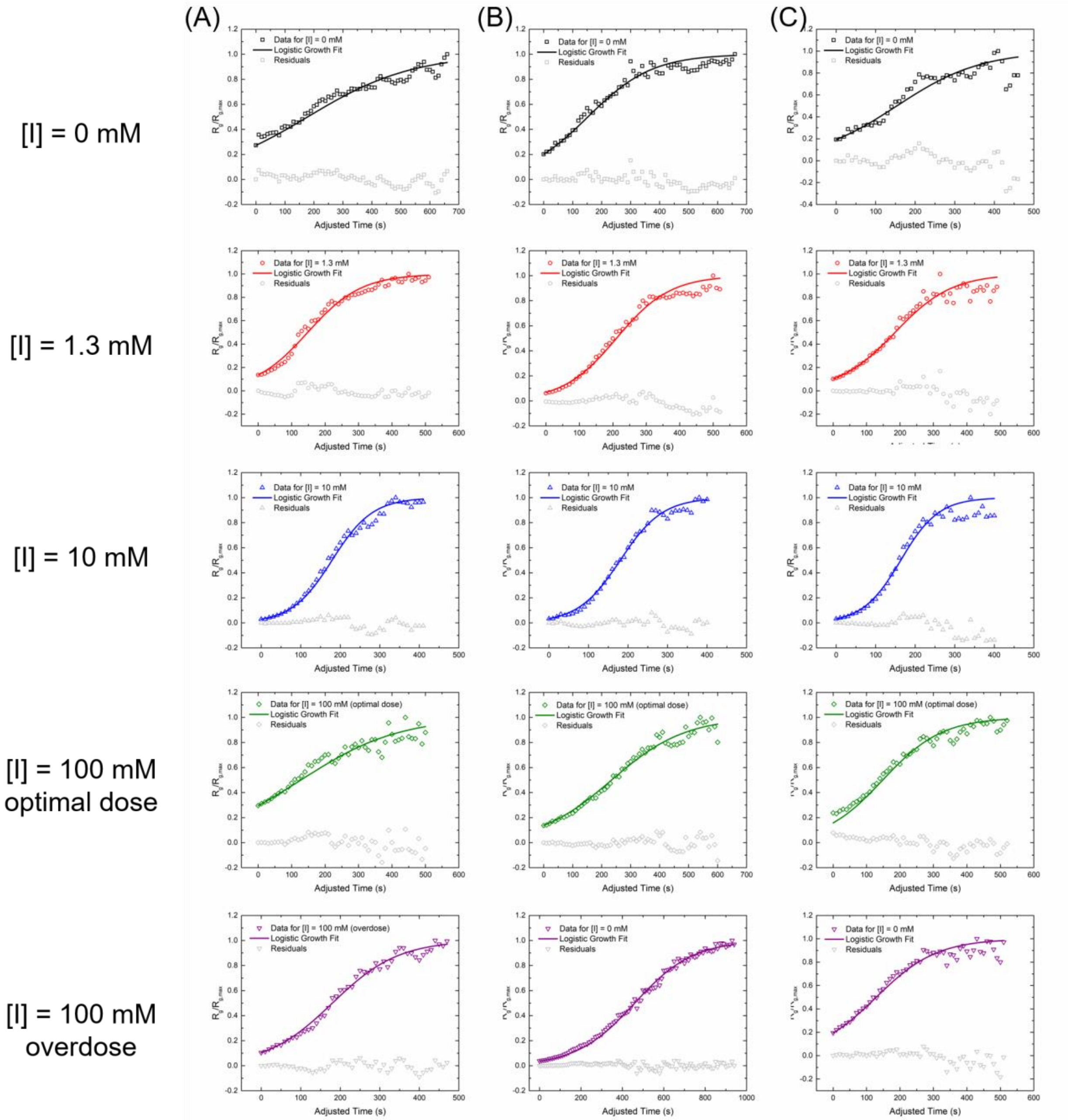

Figure 1: Logistic growth fits to floc size data over time for (A) trial 1, (B) trial 2, and (C) trial 3. The fits here are for the solutions containing the higher molecular weight polyelectrolyte (4190SSH) at all solution ionic strengths tested in this study. For each plot, the open, colored circles represent the R_g data points collected during the experiment normalized by the maximum value of R_g in the fitting range, which is where the floc size plateaus. The solid, colored line indicates the logistic growth fit. The open, gray circles represent the residuals of the fit, which is the data point calculated using the logistic growth model subtracted from the original data at each corresponding time point. The time was adjusted such that the beginning of floc growth occurs at time = 0 s.