Diffusiophoresis of Active Colloids in Viscoelastic Media

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Supporting Information

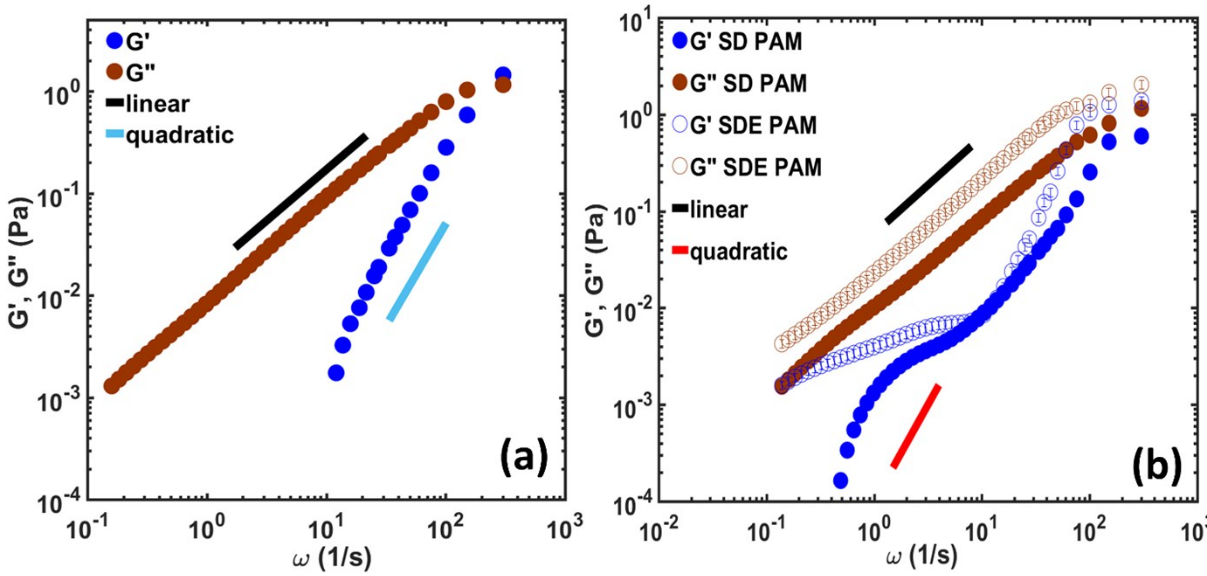

Figure S1. Storage and Loss modulus of (a) PVP and (b) PAM polymer solutions. The solid lines indicate linear and quadratic slopes and they are guides for the eyes.

Fig. S1 shows the microrheological data of dilute PVP, semi-dilute PAM and semi-dilute entangled PAM solutions. The viscoelastic spectrum, $\tilde{G}(s)$, was calculated using the Generalized Stokes-Einstein relationship in the Laplace domain using the following equation [1]:

$$\tilde{G}(s) = \frac{k_B T}{\pi a s \langle \Delta \tilde{r}^2(s) \rangle} \quad (1)$$

Where k_B is the Boltzmann constant, T is the temperature, a is the radius of the particle, s is the Laplace frequency and $\langle \Delta \tilde{r}^2(s) \rangle$ is the unilateral Laplace transform of the mean-squared displacement, $\langle \Delta \tilde{r}^2(t) \rangle$. PVP behaves as a pure Maxwell fluid [2] and the G' and G" show a quadratic and a linear behavior (terminal region) respectively. On the other side, PAM rheology is more complex with multiple relaxation times over the frequency sweep accessible. A plateau region in the storage modulus is present (less pronounced in SD PAM and clearer in SDE PAM) that clearly demonstrates the presence of polymeric entanglements.

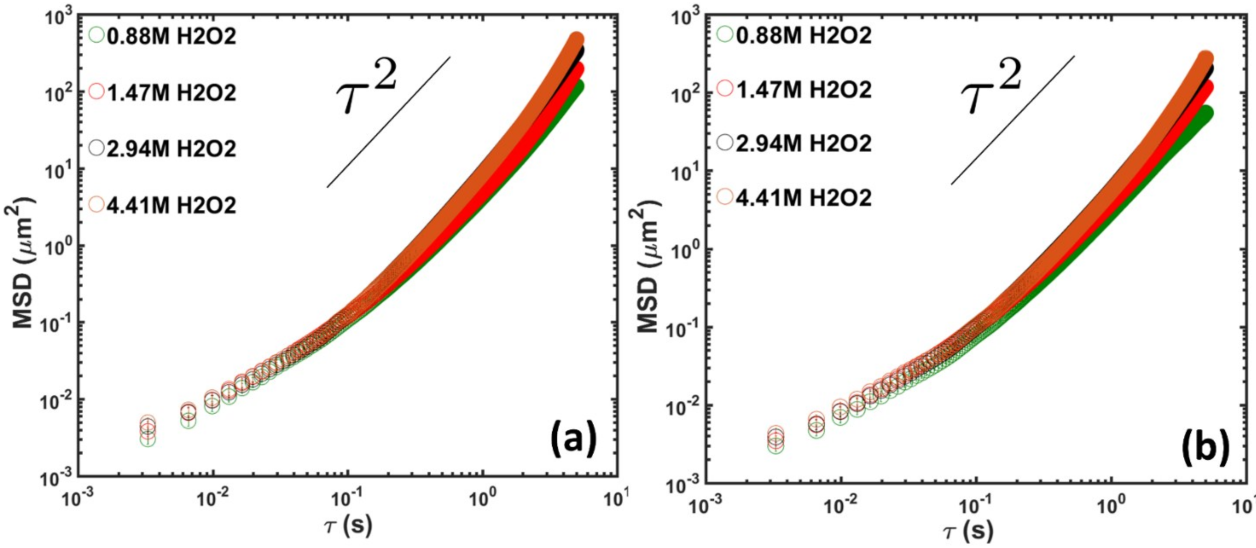

Figure S2. Active particle MSD in (a) 35% and (b) 60% glycerol solutions at different hydrogen peroxide concentrations. The black line at the top illustrate the quadratic slope and act as guides for the eye.

In Fig. S2 we show the MSDs of the ACs as a control in pure glycerol-water solutions in the absence of PVP and PAM polymers. Here we show the active dynamics of the ACs at viscosities approximately the same as it were in PVP and SD PAM polymer solutions. From the figures, we see that the MSDs over here reach a quadratic behavior as a function of hydrogen peroxide concentration without any viscoelastic effects in the media. From the quadratic fits, the particle velocities and diffusivities were extracted as shown below in Fig. S3. Here we see that both the velocities and diffusivities increase with increasing fuel concentrations.

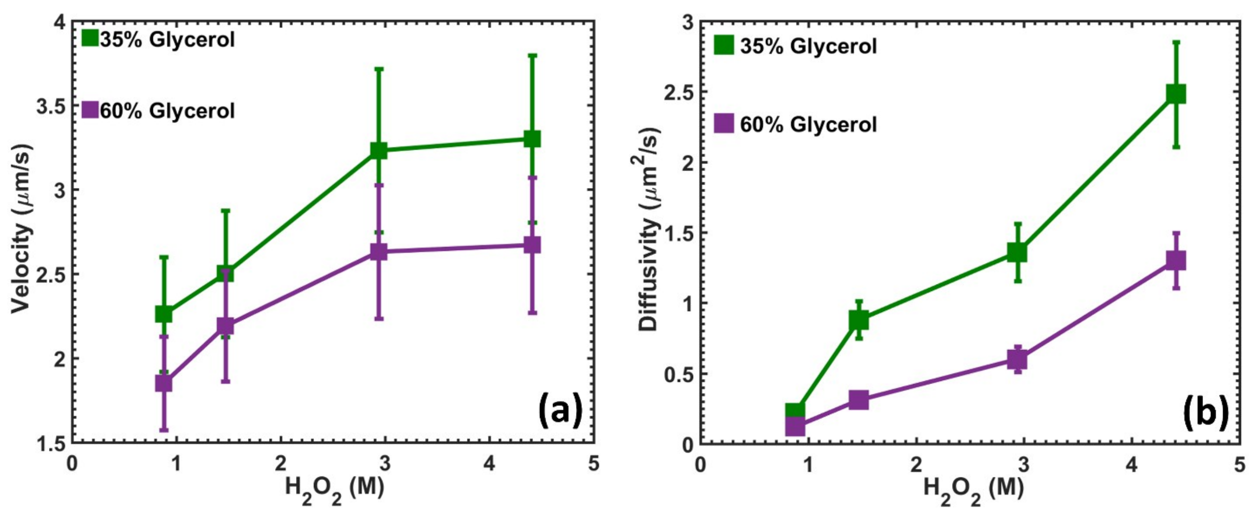

Figure S3. Particle (a) velocities and (b) diffusivities in 35% and 60% glycerol water solutions.

To complete the picture on the dynamics of the ACs in the complex fluids, the trajectories of the ACs swimming in PVP, SD PAM and SDE PAM as function of peroxide concentrations (0.88M, 1.47M and 2.94M) are here reported. In Fig. S4, S5 and S6 we report the change in particle trajectories in comparison to the Brownian trajectories. In all the figures we see that the lengths of the trajectories increase as a function of peroxide concentration as expected, but in the case of SD and SDE PAM, the particles' trajectories clearly show the confinement regions similarly to the case of 4.41M in the main part of the paper. This once again confirms the competition between active motion and physical entanglement of the particles.

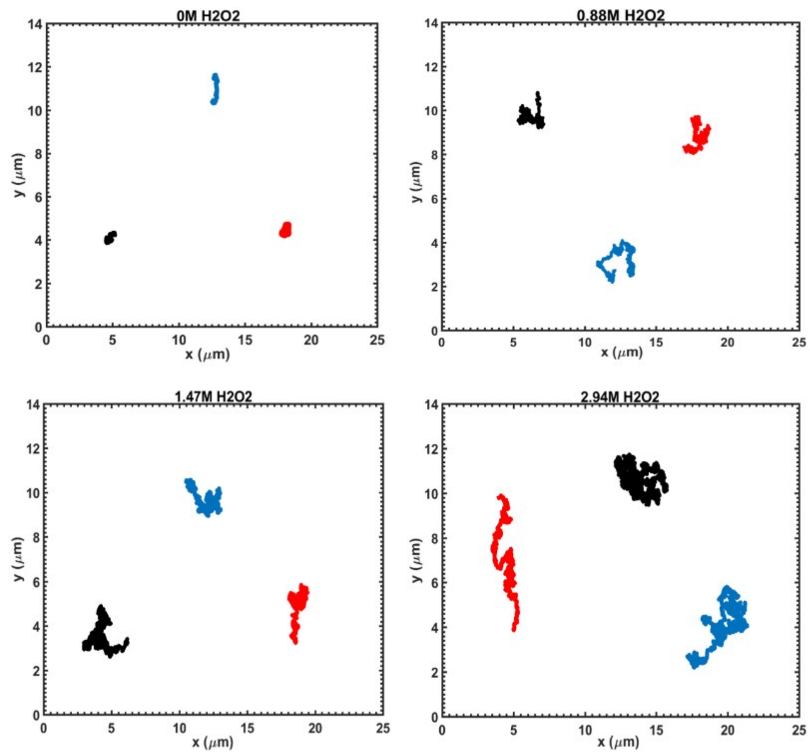

Figure S4. Trajectories of the active particles in dilute PVP system at different peroxide concentrations.

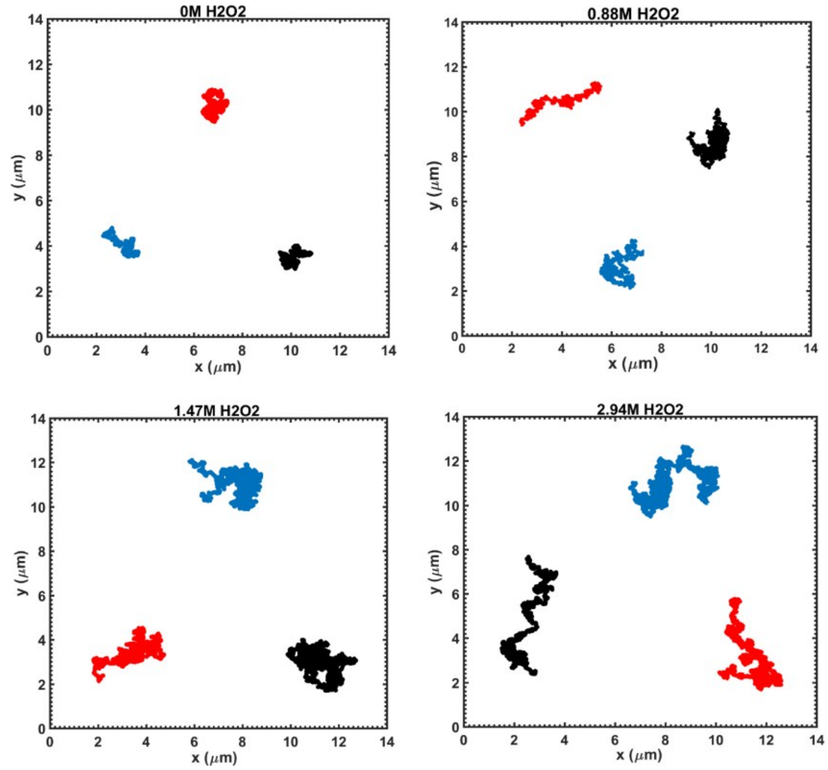

Figure S5. Trajectories of the active particles in semi-dilute PAM system at different peroxide concentrations.

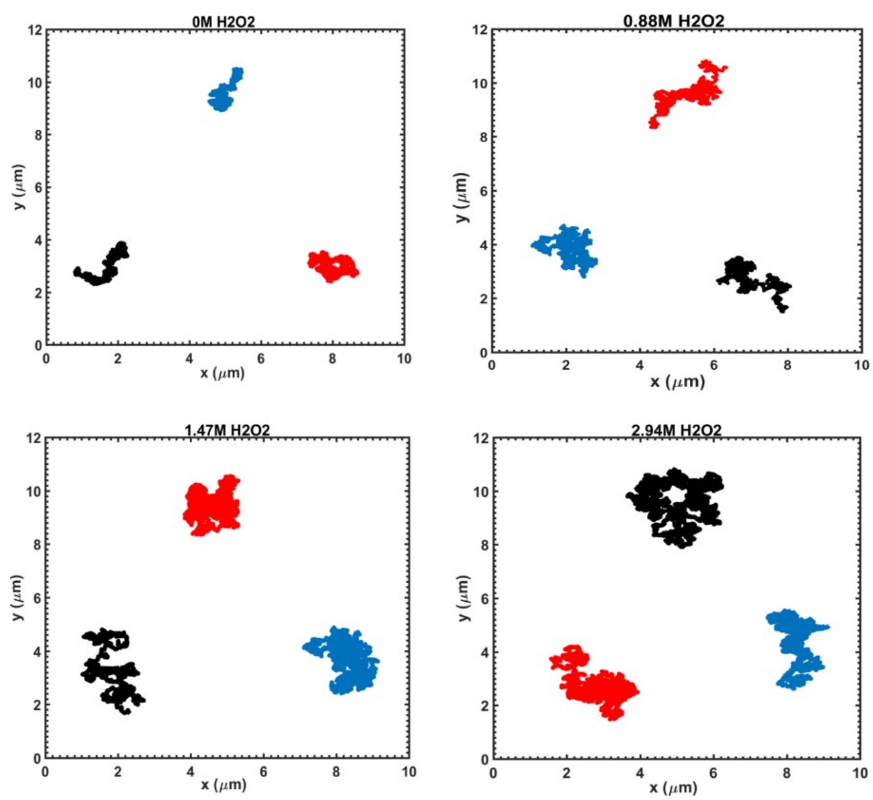

Figure S6. Trajectories of the active particles in semi-dilute entangled PAM system at different peroxide concentrations.

The following figures show a comparison between the Brownian MSD of the passive PS particles in PVP, SD PAM and SDE PAM before and after addition of hydrogen peroxide. The highest concentration of hydrogen peroxide (4.41M) was added to the systems and no significant changes in the Brownian MSD was observed. This confirms that the addition of peroxide did not induce any rheological changes to the media used in this study.

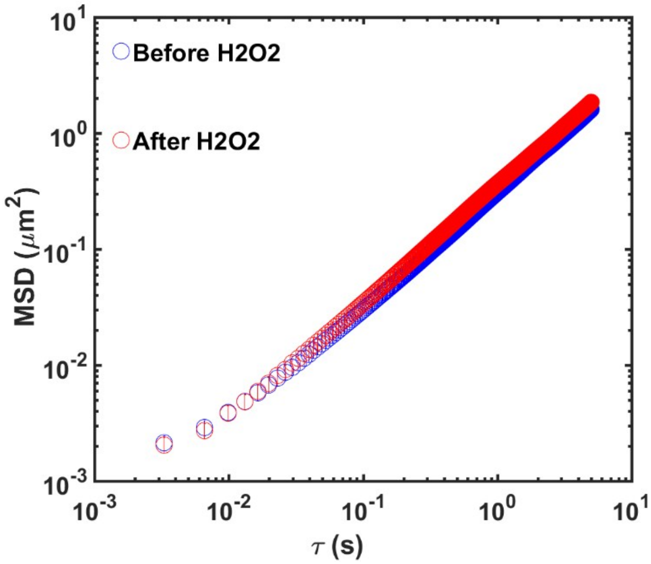

Figure S7. Brownian MSD in dilute PVP before and after 4.41M peroxide.

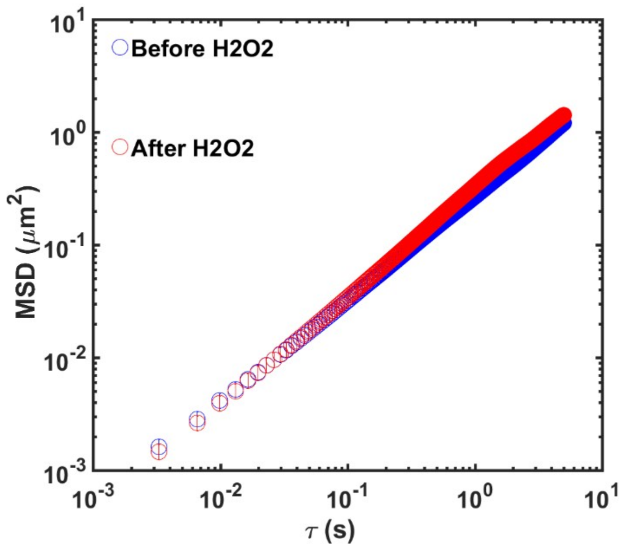

Figure S8. Brownian MSD in SD PAM before and after 4.41M peroxide.

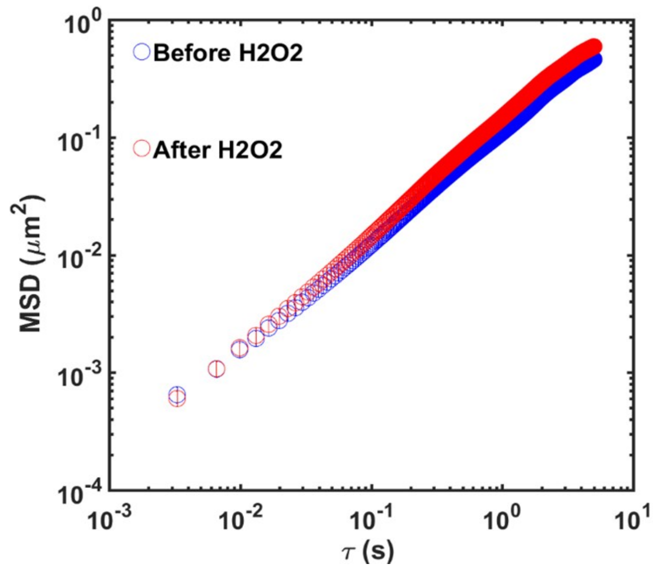

Figure S9. Brownian MSD in SDE PAM before and after 4.41M peroxide.

Supporting Videos

SI Video S1. Active propulsion of Janus colloid in dilute PVP at 4.41M H2O2.

SI Video S2. Active propulsion of Janus colloid in semi-dilute PAM at 4.41M H2O2.

SI Video S3. Active propulsion of Janus colloid in semi-dilute entangled PAM at 4.41M H2O2.

References:

1. T. G. Mason, *Rheologica acta*, 2000, **39**, 371-378.
2. F. Del Giudice, G. Romeo, G. D'Avino, F. Greco, P. A. Netti and P. L. Maffettone, *Lab on a Chip*, 2013, **13**, 4263-4271.