Electronic Supplementary Material (ESI) for Soft Matter.

SUPPLEMENTARY INFORMATION

Enhanced active motion of Janus Colloids at the water surface

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S1. Janus Particle Fabrication

Figure S1(A) shows a large scale image of the Janus colloids fabricated by sputtering. Those particles are uniform with two distinct faces, i.e. silica and platinum (Figure S1(B)). The white regions displayed in Figure S1(B) represent the platinum layer. Platinum atomic percentage measured on one meridian of a Janus colloid is also shown in Figure S1(C). Negligible values are measured far from the white face of the colloid. The platinum content progressively increases from the equator to the pole, which agrees with the expected thickness profile of the platinum layer by sputtering.[1]

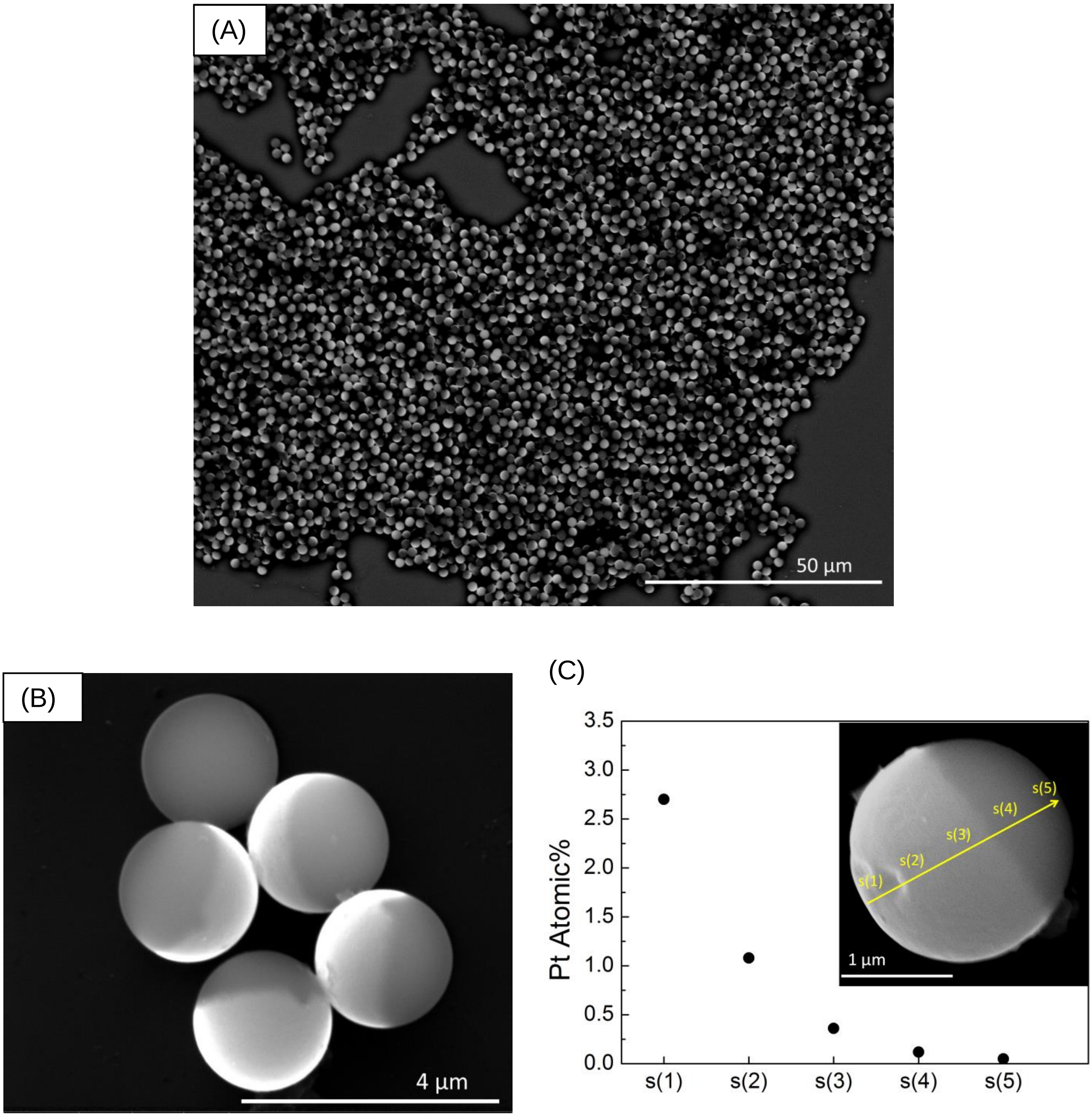

Figure S1. (A) SEM image of many Janus colloids fabricated by sputtering. (B) SEM image of five Janus colloids showing the white platinum layer (20 nm thick). (c) Platinum atomic percentage measured by SEM on five different spots s(i) on the Janus colloid.

S2. Contact angle by gel trapping

Figure S2 shows SEM images of gel trapped colloids at the interface. Visible part of the colloids was previously immersed in gelled water.

Contact angle α can be calculated by $\cos\alpha = 1 - h/R$ (h is the height of visible bead and R the radius). Averaging over more than 20 beads, we measured the contact angles of SiO_2 bead: 70.9 ° ± 3.6° and Pt-SiO_2 bead: 63.6 ° ± 2.2°.

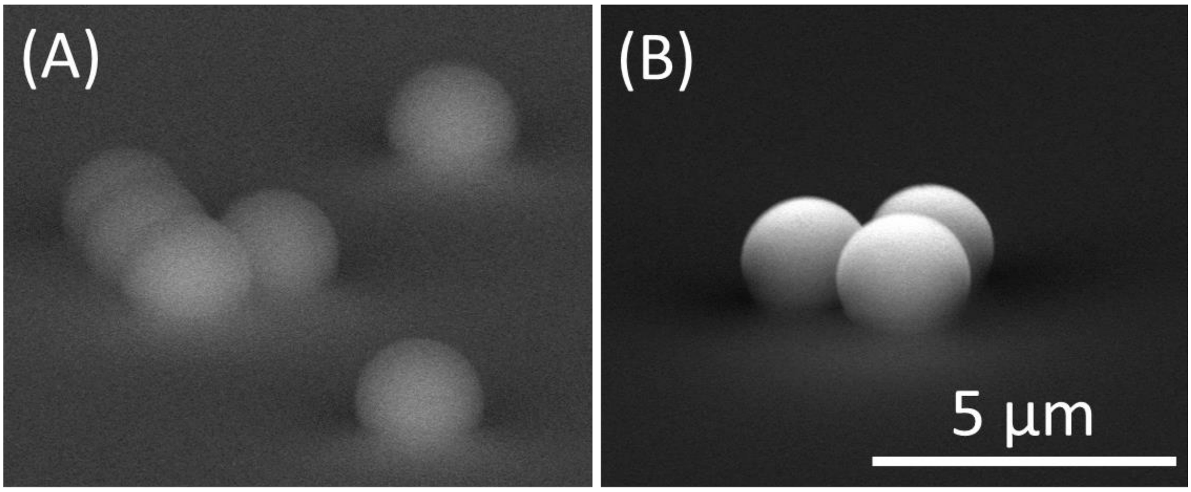

Figure S2. SEM images of (A) SiO_2 beads, (B) Janus Pt-SiO_2 beads trapped in polymerized NOA81 layers. The parts visible of beads were previously immersed in gelled water.

S3. Bulk measurements

We measured trajectories and calculated the active velocity *V* for active colloid immersed in the bulk at different H_2O_2 concentration (see also Figure S4). *V* as a function of H_2O_2 concentration is shown in Figure S3. For comparison literature data are also shown.

Differences between our data and the ones reported previously may be due to (i) a different method used to evaluate the velocity, [2] or (ii) given the weight of the colloid to a different distance to the solid wall of the glass container. In the latter case the hydrodynamic friction increases strongly when the distance between the particle and the wall decreases.[3]

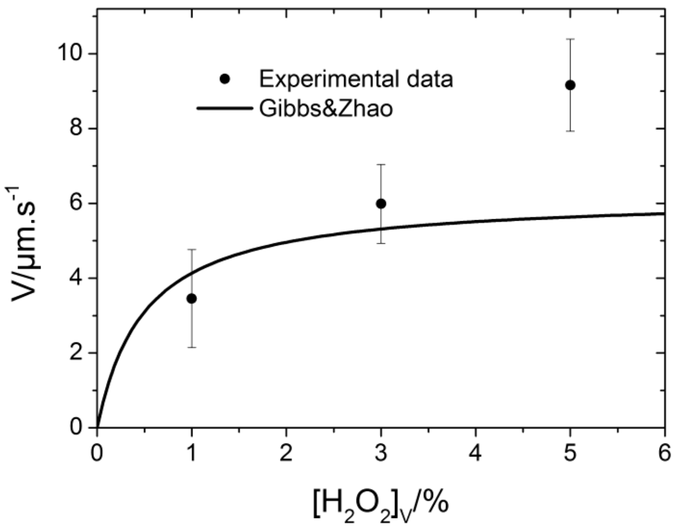

Figure S3. Active velocities from bulk experiments (filled circle). Solid curve is the fitting result of the data reported by Gibbs & Zhao.[2]

S4. Autocorrelation functions

For Janus particles at the water surface, autocorrelation functions of the velocity vector as a function of delay time are shown in Figure S4.

For active colloids in bulk the autocorrelation function of the velocity can be written as:[4]

$$<\boldsymbol{v}(\Delta t)\cdot\boldsymbol{v}(0)> = 4D_{T,0}\delta(\Delta t) + V^2 \exp(-D_R\Delta t), \qquad (1)$$

where $4D_{T,0}\delta(\Delta t)$ corresponds to the passive Brownian motion contribution to the autocorrelation, V is the active velocity and D_R is the rotational diffusion.[5,4]

The quantity $<\boldsymbol{v}(\Delta t)\cdot\boldsymbol{v}(0)>$ describes the probability of a colloid to keep the same velocity after a delay time Δt. In the run and tumble model, this probability is lost when the colloid changes significantly its direction. If τ_v is the characteristic time at which the directional change occurs, the probability becomes $(\tau_v-\Delta t)/\tau_v$ for $\Delta t < \tau_v$ and the active term of the autocorrelation is: [5]

$$<\boldsymbol{v}(\Delta t)\cdot\boldsymbol{v}(0)> = V^2(\tau_v-\Delta t)/\tau_v \qquad (2)$$

Data are fitted by equation 1 and 2 which lead to same values of the active velocity and rotational times within error bars.

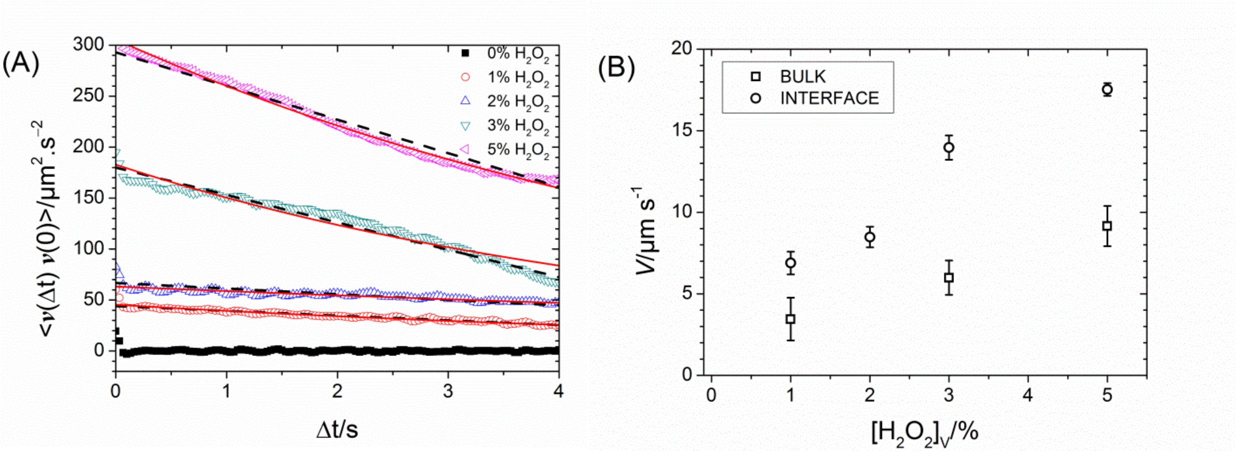

Figure S4. (A) Velocity autocorrelation functions for different H_2O_2 concentrations. Solid red lines are the fits of the data obtained with equation 1. Dashed black lines are the fits of the data obtained with equation 2. (B) Active velocity V at the interface (filled circle) and in the bulk (open squares) from the fit of the velocity autocorrelation function.

From the analysis of the velocity autocorrelation functions, the active velocity was evaluated for trajectories measured in a field of view of 477 µm × 358 µm, which agrees with the active velocity evaluated from the *MSD* in a field of view 125 µm × 94 µm (Figure 4). It increases with H_2O_2 concentration reaching $V \approx 18$ µm/s at $[H_2O_2]_V = 5\%$. For three different H_2O_2 concentrations, we have also investigated the motion in the bulk of the aqueous solution. When compared to the active velocity measured in the bulk, V is approximately twice higher at the interface (Figure S4(B)).

REFERENCES

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