Supporting information: Electric field controlled capillary traps at water/oil interfaces.

I. EXPERIMENTAL

The PS suspensions were diluted using 10 vol % of particle suspension (diameter of 3.1 μm were obtained from Interfacial Dynamics Corporation as aqueous dispersions containing 8 wt % of particles (white sulphate surfactant-free, charge density 7.4 μC/cm^2)), 40 vol % of isopropylalcohol (IPA, VWR Prolabo, 99+%) and 50 vol % of double distilled deionized water. The titanium dioxide (both pure anatase and rough surface particles) is obtained from Kemira, Finland.

An oil-water interface was created using n-decane (Acros Organics, 99+%) and deionized, bidistilled water. Prior to use, polar components were removed from the decane using adsorption onto aluminium oxide powder (Acros Chemical, acidic activated, particle size 100–500 μm). Particle monolayers were prepared by spreading droplets of the diluted suspension on a water-decane interface. The video images are captured by means of conventional microscopy. The microscopes that are used are an Olympus BX51WI fixed stage microscope equipped with a high resolution CCD-camera, (1000 × 1000 pixels, C-8800-21, Hamamatsu) or an Olympus IX71 inverted microscope equipped with a high resolution CCD-camera, (1344 × 1024 pixels, 12-bit digital camera, Orca-285, Hamamatsu, Japan).

II. SET-UP

A uniform electric field normal to an interface between two immiscible liquids is generated in a home-made cell as demonstrated in figure 1. All components, except the electrodes, of the cell are made out of PTFE. The cell is placed in a PTFE cover for safety reasons. The electrodes are two ITO coated glass slides that are fixed in a horizontal position. The field is created by applying an electric potential between the two electrodes. The potential difference was generated using a high voltage power supply (PS325, Stanford Research Systems, USA) for direct current (DC) measurements. The maximum voltage possible is determined by the thickness of the water layer. At high voltages (higher than 3000V), a water bridge is formed between both ITO glass plates.

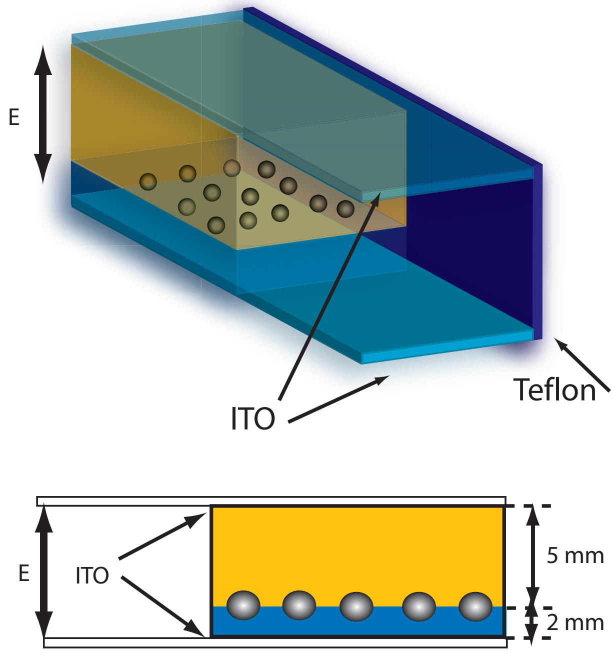

Figure 1. Experimental set-up of the electrical cell for applying a electrical field perpendicular to the interface.

III. DEPENDENCE OF E-INDUCED INTERACTION WITH DISTANCE

From the distribution of the particles in figure 3 in the Communication, the decay of the E-field induced interaction is estimated. The distance to nearest neighbors is plotted in function of the distance to the 'trap' in figure 2, and fitted with a power law function, which yielded an exponent of approximately 0.23 ± 0,05. Although surface roughness induces an interaction which is not perfectly isotropic, the distribution of the particles can be used to determine a reproducible dependence of distance-to-nearest-neighbour in function of the distance to the 'trap'.

Secondly, to verify which decay of the induced interaction fits the observations accurately, we performed some simple calculations based on earlier work of Rothen and Pieranski [1] on conformal mappings of hexagonal lattices. In the calculations, the particle density n in function of the radial distance r is determined. The strong similarity between conformal mappings of hexagonal lattices reported by these authors and the patterns observed in our work motivates us to use similar mathematical derivations for the topological description of

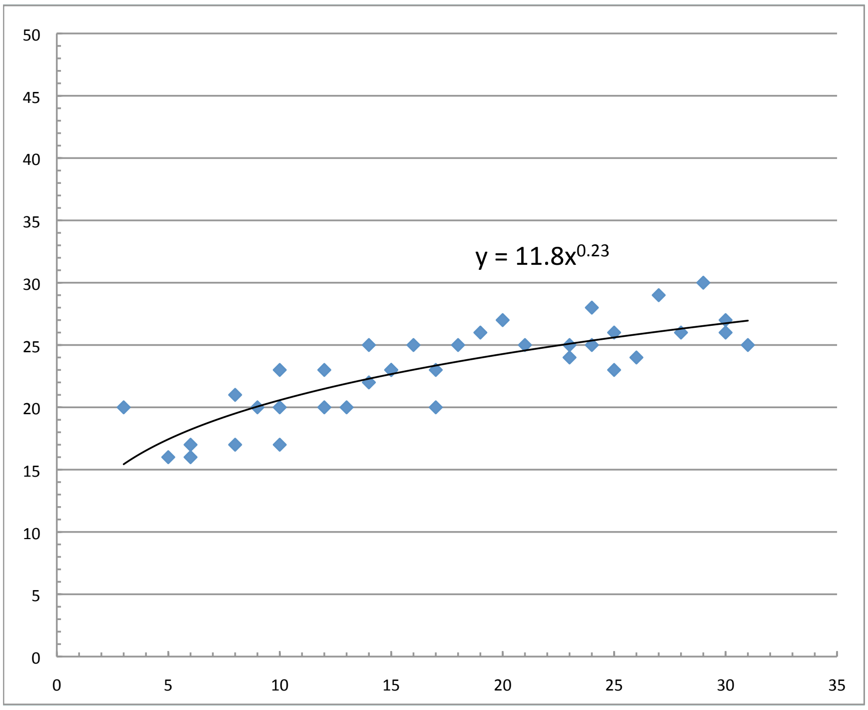

Figure 2. The distribution of PS surrounding the TiO_2 surface. The separation to the wall r is determined by the shortest distance to the TP surface. X-axis gives distance to TiO_2 particle in arbitrary units. Y-axis shows average distance between nearest neighbours at X distances from the TiO_2. The power law fit of the relation between both values is given in the graph.

the latter patterns. The particle density n in a conformal hexagonal lattice equals, for more detailed derivations see [1] :

$$n = \frac{2}{\sqrt{3}b^2}\frac{dz}{dw} \tag{1}$$

with b the distance between two particles, $\frac{dz}{dw}$ defines how the lengthscales are transformed from the perfect hexagonal lattice into the conformal mapping.

On the other hand, the long range dipolar repulsion between multiple polystyrene particles balances the E-field induced attraction. When all possible interactions between all polystyrene particles surrounding the TP are considered, Rothen and Pieranski derive that for conformal lattices it needs to be that [1]:

$$\bigtriangledown \left\{ \frac{F_{ext}}{An^{k/2}} \right\} = 0 \tag{2}$$

where $An^{k/2}$ is proportional to the interparticle interactions considering all possible interactions, and with F_{ext} the external force exerted on the polystyrene particles, which in our case equals the electric field induced attraction ($F_{ext} \sim B_1/r$, with B_1 a constant defining the system, cfr. equation 3 in the manuscript), A is a constant and k the exponent expressing the power law exponent of the polystyrene interaction (for the dipolar interaction force k=4). Then a flat interface is assumed and equation 2, can be written as:

$$n(r) \sim \frac{1}{r^{2/k}} \tag{3}$$

When equation 1 (n(r) $\sim b^{-2}$) and 3 are combined, together with a value of k equal to 4, we find a theoretical value of the power law exponent of 0.25. This value corresponds within experimental error with the experimental found value of 0.23. This resemblance suggests an externally E-field induced attraction with a logarithmically decay with distance.

Although the value of the theoretical and experimental exponent are in good agreement, we performed additional calculations for cases where the F$_{ext}$ behaves differently. Therefore, the power law exponents are determined for E-field induced attractions with a different decay behavior, as summarized in table III. The calculations reveal a significant sensitivity of the exponent on the decay behavior. From this we conclude that the E-field induced attraction

U_{coul} decay	F_{coul} decay	exponent
ln(r)	1/r	0.25
$1/r^3$	$1/r^4$	1
$1/r^6$	$1/r^7$	7/2

Table I. Theoretically based power law exponents for the distance dependence of the E-field induced attraction by a TiO_2 particle.

decays logarithmically.

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[1] F. Rothen, and P. Pieranski, Phys. Rev. E, **53**, 2828 (1996).