Electronic Supplementary Material (ESI) for Soft Matter.

Supporting Information:

Spherical nematic shell with prolate ellipsoidal core

Monirosadat Sadati[1,2], Ye Zhou[1], Drew Melchert[1§], Ashley Guo[1], Jose A. Martinez-Gonzalez[1,2], Tyler F Roberts[1], Rui Zhang[1], and Juan J. de Pablo[1, 2,*]

[1]Institute for Molecular Engineering, University of Chicago, Chicago, IL 60637, USA

[2]Argonne National Laboratory, Argonne, IL 60439, USA

[§]current address: Materials Department, University of California, Santa Barbara, CA 93106-5050

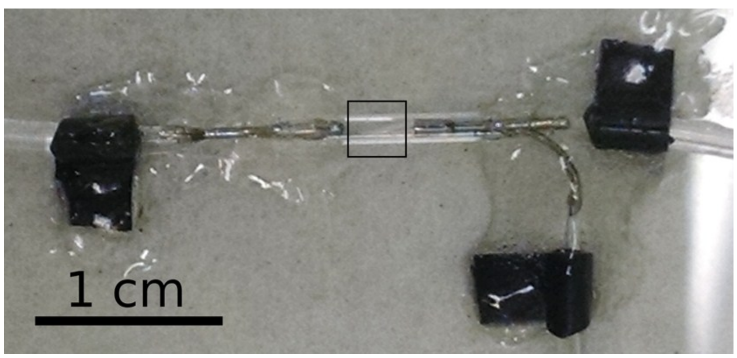

Fig. S1 Microfluidic device, where the boxed region contains the needle (the glass capillary needle is stretched to have an orifice of diameter 10μm to produce 10-20μm 5CB droplets).

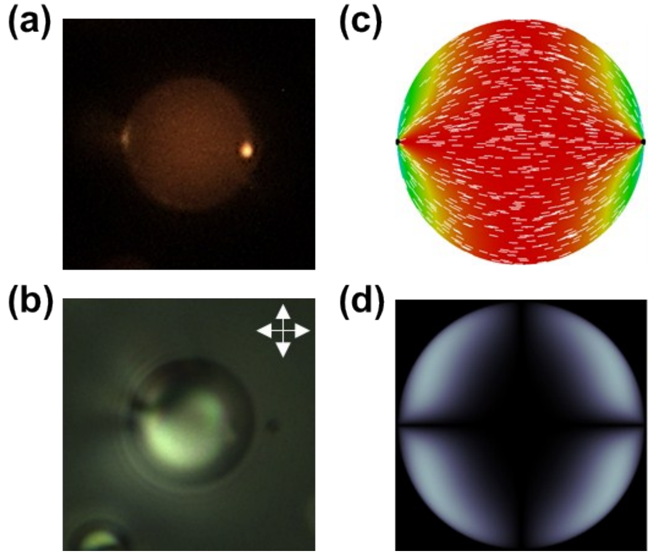

Fig. S2 Optical microscopy images and simulations of the bipolar nematic liquid crystal droplet. (a-b) are the fluorescent image and cross-polarized micrograph of a bipolar droplet. Image (a) shows the fluorescent polystyrene particles localized at the defect regions (boojums). (c, d) are the director field and simulated polarized graph for a bipolar droplet.

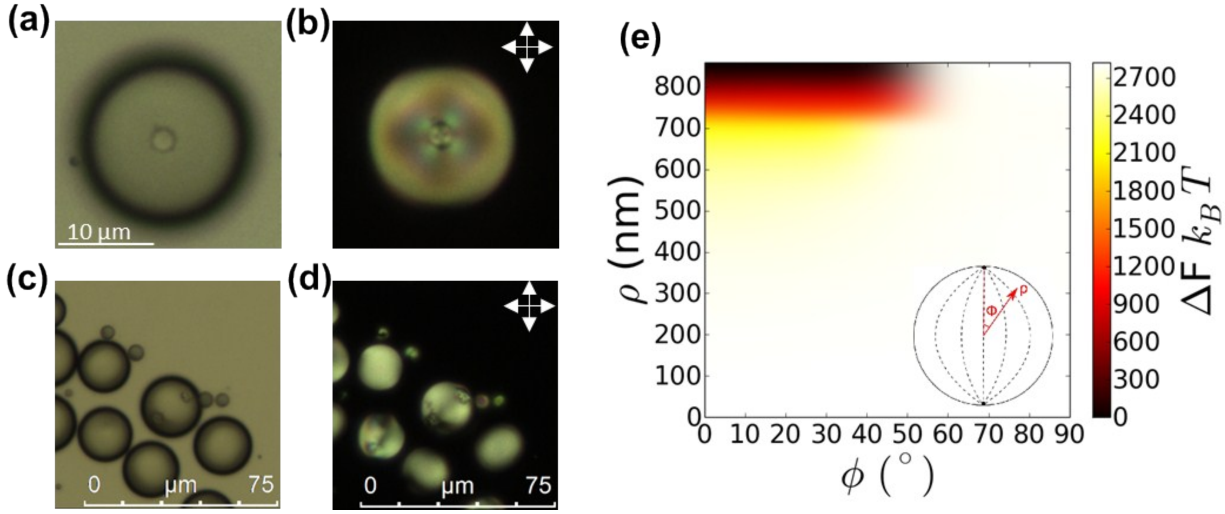

Fig. S3 Optical microscopy images of the silica particle with hometropic surface anchoring embedded in (a-b) a radial LC droplet, and (c-d) a bipolar LC droplet. (a) and (c) are the bright field images of the LC droplets and (b) and (d) are the corresponding cross-polarized micrographs. In the radial droplet, silica particles position at the center of the droplet (a, b), and in the bipolar droplet, silica particles become localized at the boojums. (e) Free energy as a function of radial (ρ) and angular (ϕ) coordinates for a homeotropic particle (Rp = 286 nm) embedded in a bipolar LC droplet (R = 1 µm). The free energy is minimized when the nanoparticle is located at the boojum positions.

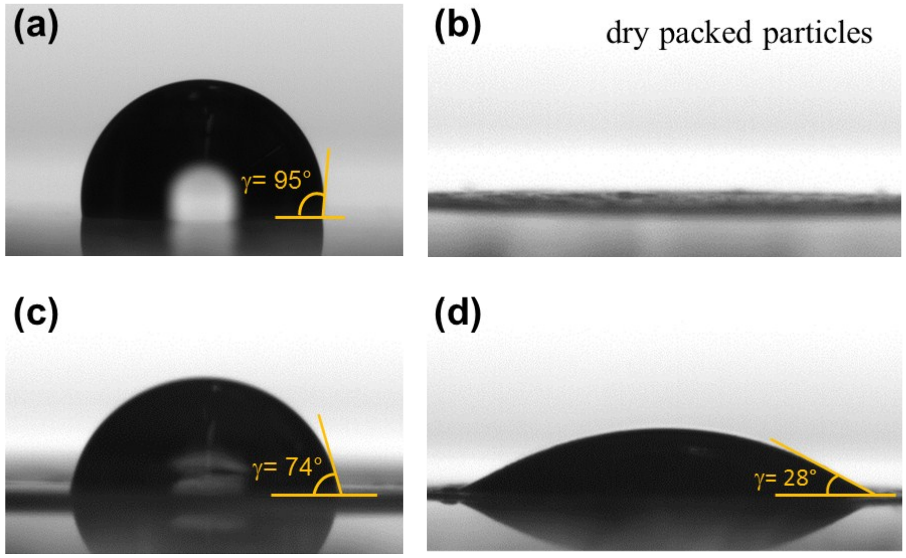

Fig. S4 Water contact angle measurement on the surface of (a) DMOAP treated glass and (c, d) packed polystyrene particles. (a) DMOAP treated glass surface, γ=95°±0.8 (c) hydrophobic packed sphere polystyrene particles before the PVA treatment, γ=74°±2.2, and (d) hydrophilic packed ellipsoidal polystyrene particles after the PVA treatment, γ=28°±3.5. (b) 0.5 mm thick film of particles was prepared by packing and drying the particles at 70°C in the vacuum oven over 5 days. Static water contact angle values were determined using an optical contact angle measurement system by Future Digital Scientific Corporation.

Free energy calculation using unequal elastic constants

In order to examine the effect of elastic anisotropy, we extend here the elastic free energy expression to include three terms:

$$F_{el} = \int_{bulk} \left(\frac{L_1}{2} \frac{\partial Q_{ij}}{\partial x_k} \frac{\partial Q_{ij}}{\partial x_k} + \frac{L_2}{2} \frac{\partial Q_{ij}}{\partial x_j} \frac{\partial Q_{ik}}{\partial x_k} + \frac{L_3}{2} Q_{ij} \frac{\partial Q_{kl}}{\partial x_i} \frac{\partial Q_{kl}}{\partial x_j} \right) dV$$

The tensorial elastic coefficients L_1, L_2 and L_3 are related to the Frank-Oseen elastic constants by $K_{11} = S_{eq}^2\left(2L_1 + L_2 - \frac{2}{3}S_{eq}L_3\right)$, $K_{22} = S_{eq}^2\left(2L_1 - \frac{2}{3}S_{eq}L_3\right)$ and $K_{33} = S_{eq}^2\left(2L_1 + L_2 + \frac{4}{3}S_{eq}L_3\right)$, where K_{11}, K_{22} and K_{33} are the splay, twist and bend elastic constants, respectively. For $K_{11} = K_{22} = K_{33}$, $L_1 = 6$ N and $L_2 = L_3 = 0$ N; for $K_{11} = 2K_{22} = K_{33}$, $L_1 = 3$ N, $L_2 = 6$ N and $L_3 = 0$ N.

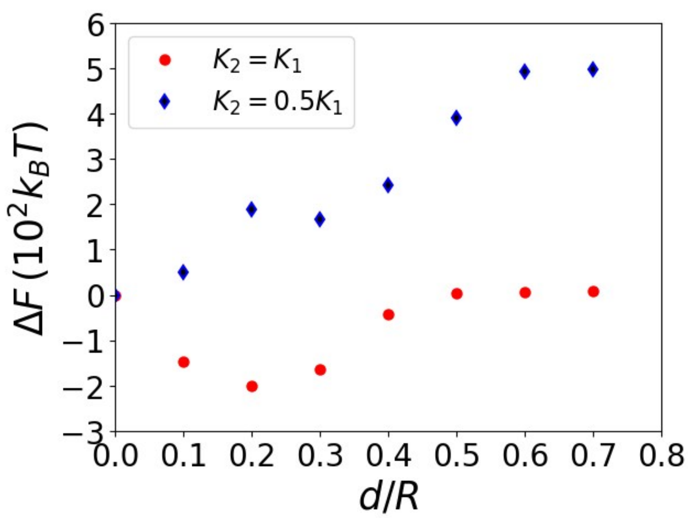

Fig. S5 Free energy difference between radial droplets with off-centered and centered particles (R_p = 100 nm) with different twist elastic constants, as a function of *d/R*, where *d* measures the distance between the droplet and particle centers. Under the one-constant assumption ($K_{22} = K_{11}$), a hybrid configuration forms and the particles are displaced laterally, driven by the elastic force. As unequal elastic constants are used ($K_{22} = 0.5K_{11}$), due to the reduced penalty for the twist distortions, the twist configuration becomes favored over the hybrid configurations. The particles are then more energetically favorable when positioned at the droplet center.

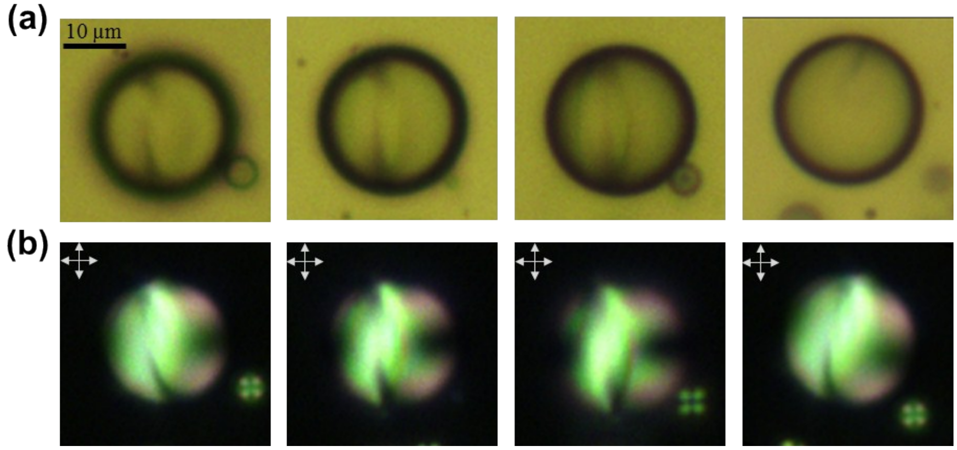

Fig. S6 (a) bright field and (b) cross-polarized micrographs of a large ellipsoidal particle encapsulated in a radial LC droplet taken at different focus distances.