Reconfigurable colloidal flocks driven by nonlinear electrophoresis in nematic liquid crystals

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We present experiments where anisometric colloidal microparticles dispersed in a nematic liquid crystal cell with homeotropic anchoring conditions are driven into self-assembly by means of non-linear induced charge electrophoresis (NLEP) [1,2] using an AC electric field perpendicular to the plates. A nematic host with negative dielectric anisotropy leads to a driving force parallel to the cell plates. We take advantage of the resulting gliding anchoring conditions and the degeneracy in the direction of particle motion to design reconfigurable trajectories using a photosensitive anchoring layer (azosilane self-assembled monolayer), as the particle trajectory follows the local director orientation.

A focalized UV light beam (Panel A) imprints radial patterns of planar alignment that prompt particles to swarm into localized vortex-like flocks (Panel B). In the absence of irradiation and applied field, self-assembled ensembles remain stable due to negligible diffusion. Flocks of particles can be reconfigured in real time by a combination of UV and visible light. For instance, they can be driven across the cell or reconfigured in lattices of different symmetry. In Panel C, a square arrangement of irradiation spots is imprinted on an initially hexagonal lattice of flocks. The particles swarm into the new stable arrangement driven by NLEP (Panels D and E).

These experiments present a simple and robust strategy for large-scale addressability of ensembles of steered colloids, with full spatial and immediate temporal control, relying solely on generic properties of the host nematic and of the dispersed materials.

References

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