Magnetic Fluid Ring: Alteration from Needle-edged to Soft-edged

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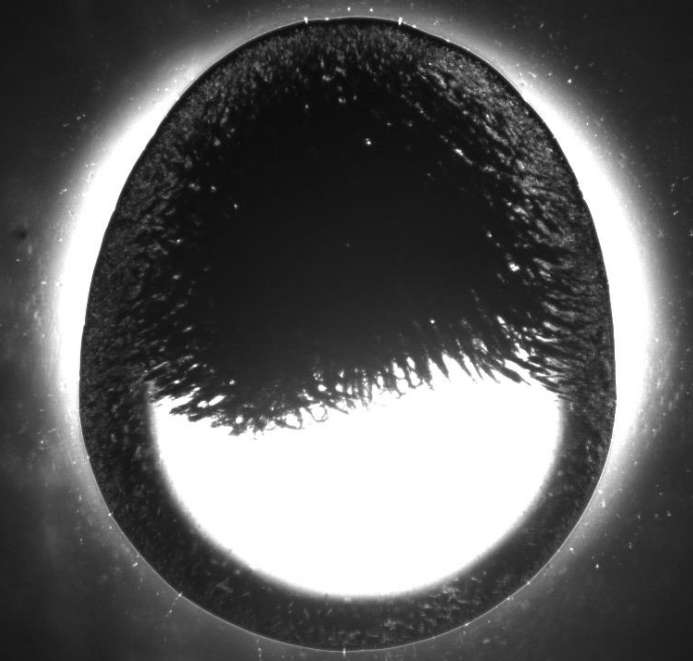
Direction of the external magnetic field

After the elimination of the magnetic field



A ferrofluid often exhibits the Brownian movements of ferromagnetic nanoparticles with diameters ranging from 2 to 10 nm in both translation and rotation under normal circumstances. Each magnetic particle has surfactant entirely encapsulated on it to avoid clumping. On the contrary, hand, when exposed to strong magnetic fields, the nanoparticles can separate from the homogeneous colloidal suspension and form an individual clump of magnetic dust. The first picture demonstrates how the addition of an extremely strong permanent magnet causes a cluster of ferromagnetic nanoparticles to grow within a ferrofluid drop put onto a glass slide, changing the shape of the drop. A certain distance distant from the droplet, the magnet was placed in the same plane as it. The ferromagnetic nanorods formed by the nanoparticles distant from the magnet at the droplet boundary are orientated toward the magnetic field because of the comparatively low magnetic attraction and strong surface tension force between the fluid-glass interface. The overall appearance is similar to a "needle-edged ring with a black stone on top."

Although the nanoparticles have a surfactant coating to avoid agglomeration, when subjected to an extremely high magnetic field, they tend to cluster. When the magnet is withdrawn, the nanoparticles should return to their original condition, but the influence of intermolecular interactions prevents them from accomplishing so. The second picture demonstrates that the conglomerated mass was unable to separate even when the nanoparticles somewhat disengaged after the magnet was withdrawn. The orientation of the ferromagnetic nanoparticle-based nanorods here is in the scattering direction, giving them a smooth look akin to dendrites. The whole image has the appearance of a "soft-edged ring with a black stone on top."