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Three-dimensional x-ray imaging of macro-clusters in ferrofluids
WAH-KEAT LEE, Argonne National Laboratory — Ferrofluids are a class of magnetic fluids where nano-sized ($\sim$ 10 nm) magnetic particles are dispersed in a carrier fluid. Ferrofluids have long been used for vacuum seals, but lately, has been proposed for a multitude of new applications including heat transfer and biomedicine. It has been known for some time that the magnetic particles tend to align with an applied magnetic field and that the individual chains can coalesce and form thick and long macro-sized structures whose shapes depend on the properties of the ferrofluid and the applied field. However, due to their opacity to visible light, ferrofluid experiments have been mainly limited to very thin films ($\sim$ 10s of microns). Since the macro-structures can be in the 10-100 micron range, thin film measurements are susceptible to wall effects. TEM and resin techniques have been used to study the structure of these clusters. However, it is doubtful if these frozen or dried structures reflect the natural fluid state. Here, we present x-ray microtomography measurements on a mm-sized tube of ferrofluid under an applied magnetic field. We show the three-dimensional nature of the columns and labyrinth structures. The measurements also allow us to provide estimates on the local magnetic particle concentration within the ferrofluid.

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