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Nanoaquarium for Imaging Processes in Liquids with Electrons[1]

JOSEPH GROGAN, HAIM BAU, University of Pennsylvania — The understanding of many nanoscale processes occurring in liquids such as colloidal crystal formation, aggregation, nanowire growth, electrochemical deposition, and biological interactions would benefit greatly from real-time, in-situ imaging with the nanoscale resolution of the transmission electron microscopes (TEMs) and scanning transmission electron microscopes (STEMs). However, these imaging tools cannot readily be used to observe processes occurring in liquid media without addressing two experimental hurdles: sample thickness and sample evaporation in the high vacuum microscope chamber. To address these challenges, we have developed a nano-Hele-Shaw cell, dubbed the nanoaquarium. The device consists of a hermetically-sealed, tens of nanometers tall, liquid-filled chamber sandwiched between two freestanding, 50 nm thick, silicon nitride membranes. Embedded electrodes are integrated into the device for sensing and actuation. To demonstrate the device's capabilities, we imaged diffusion-limited aggregation of 5nm diameter, gold nanoparticles. The rate of aggregation and the fractal dimension of the aggregate are consistent with light scattering measurements, indicating that the electron beam does not greatly alter the observed phenomenon.

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