MAR17-2016-009824

Abstract for an Invited Paper
for the MAR17 Meeting of
the American Physical Society

Sonocrystallization—application of radiation forces from acoustic standing waves for configurable assembly

CHARLES SHIELDS, Duke University

Acoustic radiation forces offer a promising approach to rapidly arrange particles across a broad range of scales, yet it remains largely unexplored compared to classical methods like centrifugation, electrophoresis, and magnetophoresis. Acoustic forces offer numerous advantages, including scalability, programmability, and the ability to manipulate particles of variable composition (i.e., without narrowly defined electromagnetic or other properties). While some groups have shown the ability to concentrate particles with ultrasonic radiation, the capabilities and limitations for precise particle assembly and morphological control remain poorly understood. Here, I will discuss our recent efforts to explore the flexibility and limitations of acoustophoresis to rapidly arrange microparticles into organized and programmable structures. In order to execute these studies, we employ a simple "sonocrystallization chamber" that creates multidimensional bulk acoustic standing waves to propel particles toward the pressure nodes or antinodes, depending on their contrast factor. We can thus create thousands of size-limited assemblies within minutes. We pair these experiments with simulations and theory to model the migration kinetics and assembly patterns of different particles types. I will further discuss how we have extended these results to understand the lower particle size limit for assembly in systems such as gold nanoparticles with diameters <200 nm. Finally, I will show how we incorporated a simple light-based crosslinking approach for stabilizing the assembly in the small particle limit (i.e., beyond the acoustic focusing limit), which might enable use in a variety of plasmonic and photonic applications.