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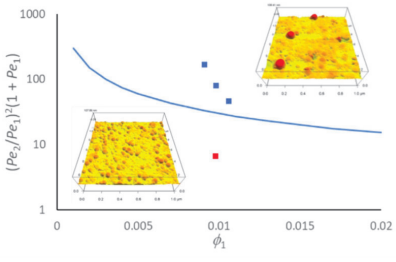
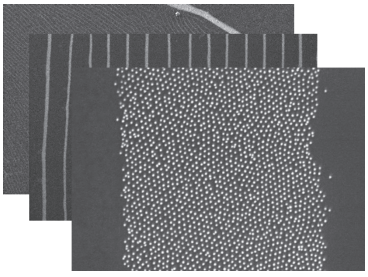
STRATIFICATION AND PATTERN FORMATION DURING EVAPORATION OF NANOPARTICLE FILMS

Multicomponent films based on nanoparticle dispersions have a wide range of applications, including antimicrobial coatings for medical instruments, conductive textiles for flexible electronics, anti-reflective coatings for optical devices, paints for humid environments that are resistant to mold growth, and drug-loaded coatings for medical implants. Often, there is a need to spatially control location of certain components in the film. For example, silver nanoparticles can be used to impart antimicrobial activity to paints, but this component is expensive and may only be needed in the top few layers of the coating, not throughout the entire film. In principle, evaporative drying of multicomponent dispersions can be used to create films with a prescribed vertical concentration profile in a one-step process. In this talk, I will present our recent results from atomic force microscopy (AFM) and small-angle X-ray scattering (SAXS) on films prepared from binary colloidal dispersions containing large and small particles of varying size and initial volume fraction. Our results show evidence of different types of stratification behavior, including large-on-top (e.g., large particles migrating to the top surface of the film), small-on-top, and "sandwich"-like layering. I discuss these results in terms of recent theories for stratification during evaporative drying. Additionally, I will present recent collaborative results on evaporative assembly of functionalized nanoparticles can yield striking dual-scale hierarchical structures. Regular microscale stripes of nanoparticle monolayers with hexagonal nanoscale order are obtained on physically and chemically homogeneous substrates through evaporation of a suspension of DNA-functionalized nanoparticles with a charged shell. The stripe width, spacing and nanoparticle ordering can be controlled by varying nanoparticle concentration and can be described by a simple analytical model. Our results indicate that the interplay between "stick-slip" motion of the droplet contact line and Coulombic and steric nanoparticle interactions control the formation of the observed structures.





ABOUT THE SPEAKER

Surita Bhatia is Professor of Chemistry and Affiliate Professor of Materials Science and Chemical Engineering at Stony Brook University. She has previously served as Vice Provost for Faculty Affairs and Chemistry Department Vice Chair. Dr. Bhatia received her bachelor's degree from the University of Delaware and her Ph.D. from Princeton University, followed by a postdoc at the Rhodia/ CNRS Complex Fluids Laboratory. She is an AIChE Fellow, Society of Rheology Fellow, and a member of the College of Fellows of the American Institute of Medical and Biological Engineering (AIMBE). Dr. Bhatia is the recipient of an NSF CAREER Award, a Dupont Young Professor Award, a 3M Corporation Non-Tenured Faculty Award, and a 2018 AIChE Women in Chemical Engineering Award for Outstanding Contributions to Chemical Engineering. Dr. Bhatia has also been a strong advocate for diversity and inclusion and has been recognized at the national level for this work.