

THE MATERIALS SCIENCE AND ENGINEERING DEPARTMENT
SPRING COLLOQUIUM SERIES PRESENTS:

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Crystal Growth at Confined Heterointerfaces

Some of the unique attributes of chemical synthesis in confined spaces is that chemical reactions can be regulated by the interface physics and chemistry. Such attributes include the interfacial energy landscape, the nature of bonds and lattice mismatch between the heterointerface layers. Each will play a role in the final resulting structure of the confined material, making the heterointerface a unique design space for synthetic chemistry of crystalline solids. In this talk, I will first discuss the use of such heterointerfaces to stabilize 2D forms of conventional solids by intercalating chemical species at the heterointerface of graphene. Confining chemical reactions at heterointerfaces will offer foundational guidance that will undoubtedly enable many discoveries in materials structure-property-functionality to come. Furthermore, a natural progression to this concept would be to spatially control chemical species that could assemble at such confined heterointerfaces to create unique structures. In this talk, I will also discuss a multiscale model to realize this by making use of the strong light-matter interaction of liquid metals to create 3D architected solids from the bottom-up. In our models, we shine a Laguerre-Gaussian mode laser beam onto a liquid gallium film to spatially structure its surface tension. Dissolved into this liquid gallium are atomic species which we treat as neutral spherical particles. The newly structured surface tension of gallium gives rise to a physical phenomenon known as the Marangoni effect. This effect allows one to engineer the convective flow patterns in the bulk of the liquid gallium film with a high degree of fidelity. The drag forces on the particles can overcome Brownian forces and precipitate out the gallium/substrate interface into a well-ordered assembly, where the structure of the precipitated particles can be controlled by changing the input of the laser beam.

Zak Al Balushi is an assistant professor in the department of Materials Science and Engineering at University of California, Berkeley and a faculty scientist in the Materials Science Division at the Lawrence Berkeley National Laboratory. Zakaria received his B.S. (2011), M.S. (2012) in Engineering Science and his Ph.D. (2017) in Materials Science and Engineering all from The Pennsylvania State University. His early work focused on integration and fabrication of silicon nanowire devices, then on the growth of group-III nitride semiconductors, in situ metrology during MOCVD growth, epitaxial graphene and the discovery and characterization of unconventional low-dimensional materials and heterostructures. Prior to his appointment at the University of California, Berkeley, he held two postdoctoral fellowships: the Resnick Prize Fellowship in Applied Physics and Materials Science and the NSF Alliances for Graduate Education and the Professoriate (AGEP) Fellowship both at the California Institute of Technology under the supervision of Professor Harry Atwater. At Caltech, he focused on the synthesis and characterization of phase transformations in transition metal dichalcogenides 2D materials. At the University of California, Berkeley, his research group continues to expand in this area and beyond, creating new synthesis and integration schemes for emerging low-dimensional materials. He is currently serving on the editorial board of Communications Materials, is a Principal Editor for Journal of Materials Research and an elected executive committee member for the American Association for Crystal Growth. He is also a SK Hynix Faculty Fellow, Society of Hellman Fellow, and a recipient of the NSF CAREER award in 2022.

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