Chemical Engineering

Fall 2021 Seminar Series

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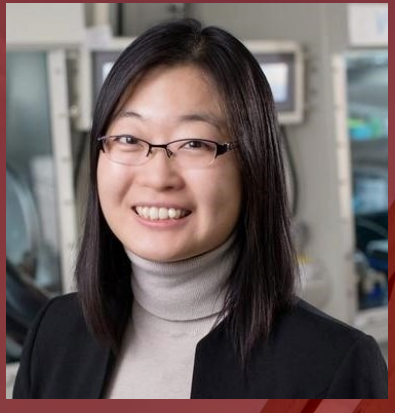
Understanding Assembly Pathways for Printing Functional Soft Matter



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Friday, 29 OCT 2021
3:00pm
via Zoom (link to be sent day of seminar)

ABSTRACT: Printing technologies have the potential to revolutionize manufacturing of electronic and energy materials by drastically reducing the energy cost while increasing throughput and agility. At the same time, additive manufacturing of such *functional* materials brings a new set of challenges demanding exquisite control over hierarchical structures down to the molecular-scale. During printing, the molecular assembly process strongly couples with multiphase interfaces and fluid flow, giving rise to intriguing far-from-equilibrium phenomena and offering opportunities to direct assembly by designing non-equilibrium drive forces. Inspired by biomolecular templates capable of surface reconfiguration, we developed a new concept of dynamic templating to direct assembly of pi-conjugated semiconducting polymers across length scales during solution printing. We showed that surface reconfigurability of dynamic templates enables cooperative multivalent interactions with the assembling media to attain a level of morphology control beyond that achieved using rigid (static) templates. Besides interface-directed assembly, we are keenly interested in flow-driven polymer assembly central to all printing processes. Integrating in situ imaging, scattering, spectroscopic experiments with finite element simulations, we discovered that printing flow can drastically alter chiral-liquid-crystal-mediated assembly pathways of conjugated polymers as to largely modulate charge transport and optoelectronic properties. The ability to control non-equilibrium assembly during printing sets the stage for dynamically modulating assembled structures on the fly. We demonstrated this concept by programming nanoscale morphology and structure color of bottlebrush block copolymers during 3D printing. *In sum, our directed assembly approaches add a new dimension to additive manufacturing, enabling us to print functional polymers with precise multiscale structure and even programmable properties.*