

CHEMICAL ENGINEERING

DISTINGUISHED YOUNG SCHOLARS SERIES



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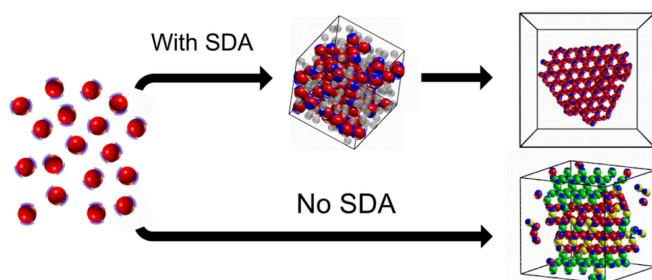
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Postdoctoral Fellow

National Institute of Standards and Technology

Structure-Directing Soft Matter Agents: A New Twist on Colloidal Crystal Assembly

ABSTRACT: Globally ordered colloidal crystal lattices have broad utility in a wide range of optical and catalytic devices, for example, as photonic bandgap materials. However, the self-assembly of stereospecific structures is often confounded by defects due to, for instance, polymorphism. Weak free energy differences and complex hierarchical length scales often characterize ensembles of these structures, making it difficult to produce a single morphology at will. Current techniques to handle this problem adopt one of two approaches: that of the “top-down,” or “bottom-up” methodology whereby structures are engineered starting from the largest, or smallest relevant length scales, respectively. The ubiquitous design strategy in such approaches is energy minimization; many colloids have been computationally engineered with anisotropic pairwise interactions to achieve morphological control in theory. However, the complexity of these designs often makes experimental realization difficult. In this talk I will demonstrate how the introduction of polymer co-solutes into crystallizing colloidal suspensions can be employed to design the resulting nano- and mesoscale colloidal structures by relying upon the polymer's entropic interactions alone. [1-4] These entropic interactions result entirely from the interplay between the polymer's internal degrees of freedom and the void structure of the resulting crystal. I will elaborate on how this “structure directing agent” (SDA) paradigm reveals how to rationally design the polymer SDA morphology to thermodynamically stabilize a single desired close-packed crystal polymorph in a binary mixture, [1] and the consequences of enthalpic perturbations. [2] I will then offer insights into how to design temperature-dependent polymer “switches” that allow the stability of a crystal polymorph to be controlled via experimentally accessible



LECTURE 4:00 – 5:00 (PAA) A110
Happy Hour in Benson Hall Lobby Following



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parameters, [3] and how this mechanism can be generalized to produce complex, diamond-like crystal morphologies. [4] The high degree of transferability of this paradigm's basic principles between relatively simple crystals and more complex ones demonstrates the value and novelty of this approach compared to presently known colloidal self-assembly techniques.

BIOGRAPHY: Nate Mahynski is a NRC Postdoctoral Fellow at the National Institute of Standards and Technology (NIST) in Gaithersburg, MD. He graduated from Princeton University in 2015 with his Ph.D. in Chemical Engineering where he received a NSF Graduate Research Fellowship to study colloidal science. He was later awarded a Gordon Wu Prize for Excellence for his work in the field, and in 2015 he received the Christopher J. Wormald Prize for his contributions to the theoretical understanding of crystallization phenomena in colloid and polymer mixtures. His current research focuses on using computational tools to study the thermodynamics, structure, and self-assembly of soft matter and complex fluids. He is originally from Michigan, and loves to experience the great outdoors through hobbies including skiing, hiking, and golfing.

REFERENCES:

- [1] Mahynski, et al., Nat. Commun. 5, 4472 (2014).
- [2] Mahynski, et al., Soft Matter 11, 280-289 (2015).
- [3] Mahynski, et al., Soft Matter 11, 5146-5153 (2015).
- [4] Mahynski, et al., ACS Nano 10, 5459-5467 (2016).