Resolving Challenges in Self-Assembly with Nano Real Space Analysis

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1. Abstract

While the free energy landscape provides a robust framework by which one may hope that targeted self-assembled structures may be formed, in experiments the success rate for reaching such an end-point has been described as “so bad you wouldn’t believe it”.

Although computer simulations can provide some help to predict self-assembly pathways, a critical challenge lies in understanding at what point the pathway through the system becomes kinetically arrested in experiment. Particularly vexing is that the majority of experimental probes provide only a posteori information (such as electron microscopy or tomography) or reciprocal space data (such as x-ray or light scattering). Here we propose that the recent breakthrough in optical imaging to enable super-resolution microscopy provides a unique opportunity to address the challenge of understanding “what went wrong” with in-situ dynamic observation of self-assembly at the nanoscale. We demonstrate our approach with examples of imaging of nanoparticles and self-assembly of novel protein based materials with designer functionality from enzymatic processes to energy generation.