Investigation of pathways and kinetics of protein assembly via *in situ* scanning probe microscopy

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One of the most powerful characteristics of biological systems is their ability to assemble individual molecules into large, complex, functional structures in the form of particles, fibers, ribbons and sheets. While the instructions for assembly lie in the molecular structures of the components, their geometries, and the precise positioning of functional groups that provide the intra- and inter-molecular interactions, functionality depends on the nanoscale architectures that emerge through self-assembly. Over the past few years, we have used in situ scanning probe microscopy (SPM) to investigate such assembly processes in order to understand the underlying physical controls governing assembly. Insights attained from these experimental efforts and further reinforced by modeling efforts will lead to great advances in such functional devices as battery electrodes, artificial membranes, hard and soft tissue implants, and nanobioelectronic sensors. In this talk I will recent results of in situ SPM investigations into how surface-layer (S-layer) proteins self-assemble in real time and form 2D crystals in a cell-like environment. This direct observation of protein assembly could provide researchers with insights on how these organisms stave off antibiotics or lock carbon dioxide into minerals.