

Cryo-electron tomography of chiral plasmonic superlattices

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Controlled assembly of colloidal nanoparticles into ordered arrays (i.e., superlattices) offers routes for a new class of metamaterials with tunable structure and properties [1]. There is a growing interest in utilizing biological particles such as proteins, nucleic acids, and virus particles as templates to direct the assembly of metal nanoparticles [2]. The atomically precise nature, well-defined surface functionalities, and inherent chirality of the biological particles allow hybrid chiral plasmonic objects for new generation optics, photonics and catalysis [3]. However, providing direct evidence on the self-assembly pathway in solution state and determining the three-dimensional structure of bio-based hybrid superlattices is a major challenge. Due to their delicate nature, conventional transmission electron microscopy (TEM) imaging results in unwanted drying artifacts. Moreover, the traditional TEM images produce two-dimensional (2D) projections of 3D objects [4]. In this context, cryogenic-TEM imaging offers the ability to monitor the self-assembly process and the final structure in their near-native state with minimum artifacts. Cryo-electron tomography provides detailed morphological features and packing patterns of the building blocks. In this presentation, we will discuss the electron tomography reconstruction of selected chiral plasmonic superstructures and their applications [5]. Specifically, we will show the critical role of Cryo-TEM and ET methods in unraveling the self-assembly mechanism, complex 3D structure, and packing pattern of gold nanoparticles when treated with rod-like virus particles (**Figure 1**), DNA origami, and cellulose nanocrystals [6,7]. Finally, we present how the 3D coordinates extracted from ET data allow the computational simulation to understand the mechanistic pathway of self-assembly and the origin of chiral plasmonic properties.

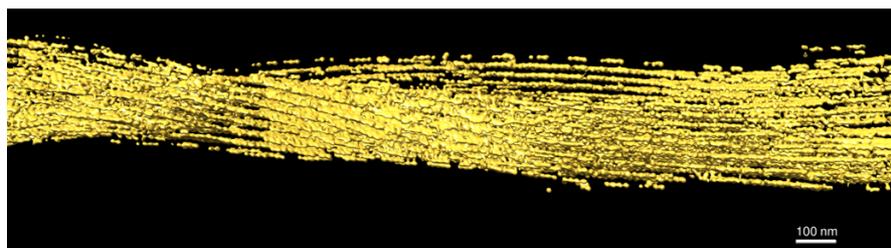


Figure 1. Cryogenic electron tomogram of a self-assembled helical microwire.

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