Virotronics: Making Virus Work For Us!

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A fundamental challenge in bio-nanoscience is to identify an active building block that can perform highly selective functions with remarkable precision based on specific recognition, programmable self-assembly, and non-toxic biocompatibility. Biological building blocks, such as DNA, peptides, and lipids, have been utilized to create vesicles, nanofibers, nanotubes, and two-dimensional synthetic hierarchical structures. By responding to external stimuli, artificial DNA, conjugated with nanoparticles and peptide amphiphiles, can self-assemble in reversible patterns to form hierarchical nanostructures and perform specific functions. However, their functions and precision are still not comparable to those of biological systems: bones, brittle stars, abalone shells, and diatoms can orchestrate remarkable spatial and temporal control on both the nanometer and micrometer scales during the mineralization process. Identifying potential functional nanoscale basic building blocks from living systems is still challenging because of long encrypted peptides and genes.

In my presentation, I will demonstrate virus-based nanomaterial design principles which exploit the unique biological advantages from viruses, such as evolution, specific recognition and self-replication. In addition, engineering aspects include information mining, storage and translation, as well as structural self-assembly. We term our novel virus-based materials design approaches as “Virotronics”. Using Virotronics approaches, I will introduce how we design novel functional materials such as soft- and hard-tissue regenerating materials, specific bio-sensor devices, and photonic and energy producing devices using genetically engineered viruses.

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