Designed Nanomaterials via Programmable Self-Assembly

Objectives
The ability to organize nano-components into the desired organizations is one of the limitations for creating nanomaterials with targeted functions. Our efforts are focused on establishing a broadly applicable DNA-based platform to address this challenge. We explore new concepts for creating targeted static and dynamic nano-architectures from nanoparticles and biomolecules. We are also applying self-assembly methods to create novel materials with optical, chemical, sensing and mechanical functions.

Motivations and Approach
Particle cores are inorganic, carry function.
Shells from DNA dictate interactions.

Prescribed 3D Structures
Nano-cubes can direct spheres into formation of clusters with 6-fold coordination.

Platform for Nanoscale Organization
3D Assembly via Valence-prescribed Material Pixels:
Establishing a broadly applicable self-assembly platform

Optical Nanodevices
Gold Nanoparticle-Quantum Dot Clusters:
Assembly of 3D Arrays of Quantum Dots:
Enzyme Arrays for Catalytic Cascades:
Pepptide coated DNA constructs anti-cancer drug delivery

New functions through self-assembled nanomaterials
Designed Bio-nano systems
Mechanical Responses
Designed ordered “gel”:

Switchable Materials
Dynamic Control of DNA Shells for 3D Lattices of Nanoparticles
Programmable Shells
DNA signals can be used to reprogram the shells of spherical gold nanoparticles and thus their interactions, allowing for the selective transformation of the self-assembled structure.