Project Abstract/Summary

The future of functional materials depends on the development of new synthetic strategies for generating materials with highly desirable but currently inaccessible chemical and physical properties. Although silicon has interested scientists for centuries, it was not until methods were developed for engineering single crystal silicon that the electronics industry was revolutionized. Analogously, we believe the ability to assemble nanomaterials utilizing the programmable nature of DNA over many length scales will transform several areas, including the fields of catalysis, sensing, and optics. To date, DNA programmed materials have mainly focused on the synthesis of superlattices formed from a small subset of inorganic nanomaterials. However, conceptually any particle, including an engineered protein or virus, can be modified in similar ways to create a wide class of "programmable atom equivalents" that can be assembled into preconceived and deliberately designed single crystal architectures. Through the NSSEFF grant we will use rigorously tested design principles to create novel and functional materials based upon the precise placement of particle constituents. Specifically, our proposed project will focus on five interrelated areas: 1) the development of nucleic acid functionalized building blocks from both hard and soft matter; 2) methods for guiding their assembly into superlattices with controlled crystalline morphologies; 3) novel catalytic materials with programmable periodic architectural parameters, 4) their utilization as ultrasensitive biodetection systems with unusual and potentially useful molecular recognition and amplification properties, and 5) the development of optically responsive materials from single crystal architectures of nanoparticle superlattices.

The effort will be led by Chad Mirkin, who has an exceptionally strong track record of working with military labs, including the AFRL, ARL, NRL, and SBCCOM. Mirkin also holds a security clearance and has the requisite experience to successfully direct an operation of this magnitude in such a way that it substantively benefits the DoD.