Center for Templated Synthesis and Assembly at the Nanoscale

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The University of Wisconsin at Madison (UW), one of the largest public research universities of the nation, has built much of its reputation and success on a strong tradition of collaboration between the science and engineering disciplines. The UW Nanoscale Science and Engineering Center (NSEC) assembles a diverse group comprising established, world-renowned senior faculty and promising junior faculty from over ten departments. The tightly interwoven multidisciplinary program addresses the self-assembly of complex materials and building blocks at the nanoscale with an exquisite level of detail, including the development of a unique program to explore their societal implications. The UW possesses the infrastructure and breadth of expertise required for a successful and vibrant NSEC. The research mission of the NSEC is organized into four interdisciplinary research thrusts that explore the concept of self-assembly at the nanoscale from different angles:

Thrust 1: *Directed Self-Assembly and Registration of Nanoscale Chemical Architectures* addresses the question of assembling nano-structured objects into functional nanoscale systems. It explores the self-assembly of block copolymers on nanopatterned substrates, the convergent assembly of pre-fabricated nanoscale elements on nanoscale patterns, and the biologically-directed assembly of nanowires and nanorods for development of innovative biosensors. The group relies on superb nano-patterning facilities and considerable expertise in the synthesis, manipulation and characterization of nanoscale building blocks, ranging from flexible copolymers to rigid nanowires.

Thrust 2: *Templated Chemical Synthesis of Sequence Specific Heteropolymeric Nanostructures* explores guided processes of chemical synthesis and assembly on the nanoscale. The group seeks to establish novel thermodynamically-controlled, template-directed synthetic strategies that bring an unprecedented level of control to the synthesis of amide heteropolymers with discrete sequences, shapes and assembly propensity. The group also explores the self-assembly of synthetic, highly stable but unnatural β-peptide sequences into unique nanostructures which are carefully characterized and examined in the context of several applications, including their use for antimicrobial materials and liquid-crystal based biosensors.

Thrust 3: *Driven Nano-Fluidic Self Assembly of Colloids and Macromolecules* relies on concerted experimental and theoretical approaches to explore the use of non-equilibrium processes, such as the use of flow and other fields, for nanoscale assembly and manipulation of nanoparticles and macromolecules, including DNA, under severe confinement. The group builds on its recent successes in rapid optical mapping of entire genomes and in development of unique multi-scale modeling techniques to develop entirely new ways of producing synthetics genes, and to develop nanofluidic liquid-crystalline based processes for assembly of photonic crystals.

Thrust 4: *Research in the Societal Implications of Template Synthesis and Assembly at the Nanoscale* is a one-of-a-kind partnership with the Holtz Center for Science and Technology Studies and the La Follette School of Public Affairs at UW that is developing an integrated,

multidisciplinary understanding of nanoscale science and engineering as it moves out of the laboratory and into society and to build a public dialog about its societal, ethical, legal, and policy implications.

Thrust 1 examines situations and processes in which the self-assembly of mesoscopic materials and the resulting nanostructures can achieve a state of thermodynamic equilibrium. Thrust 2 considers synthetic routes that are also governed by thermodynamic equilibrium and nanoscale templates, but this time at the level of individual atoms and chemical reactivity. Thrust 3 is concerned with nanoscale self-assembly far from equilibrium, driven by the influence of external fields and severe confinement. Thrust 4 considers social influences on and implications of the development, design, reception, and uptake of self-assembling nanotechnological systems.

Each group integrates the five essential elements required for forefront research in nanoscale science and engineering: synthesis, theory, structural characterization, property evaluation, and applications. An aggressive Seed program operates in a manner to foster innovation and promote growth and evolution into new, unexplored areas of opportunity. Seed funds are primarily used to support promising clusters of individuals in emerging areas of nanoscale science and engineering and its societal implications. The established Thrusts and Seed projects share a common view, namely the precise synthesis of nanoscale elements, their assembly into nanostructured systems through the use of templates, self-organization and confinement, and the creation of materials, devices, and processes with hitherto unattainable functions. The way in which the center has been conceived is such that each Thrust is capable of operating in a self-sufficient manner, but multiple cross-Thrust activities and interactions that capitalize on a multidisciplinary environment are essential for successful completion of the research.

The NSEC also operates an ambitious and unique education and outreach program aimed at cultivating the next generation of nanoscale science and engineering experts. The NSEC builds on the UW's vast experience in scientific education and benefits from infrastructure provided by the Institute for Chemical Education, the Journal of Chemical Education, and the National Science Digital Library. A wide array of education and outreach activities ensures that all NSEC faculty and students participate effectively in education and outreach. An additional partnership with the UW's Business School assesses the commercial potential and possible pathways to commercialization of technologies under development in the NSEC.

The NSEC activities include the establishment of a Graduate Fellowship Program to recruit the most talented young scientists and engineers to the interdisciplinary field of nanoscale science and engineering and to foster a community of diversity. We have also established links to international laboratories on three continents that support living expenses of our students while they participate in substantive collaborative co-supervised research projects.

The shared experimental facilities of the proposed NSEC includes nanopatterning and surface sensitive characterization of materials, and leverages existing state-of-the-art instrumentation, human resources, and user networks of three organizations of national and international reputation at UW: the NSF sponsored Synchrotron Radiation Center (SRC), the NSF sponsored MRSEC, and the Center for NanoTechnology (CNTech). Supporting infrastructure is also provided by the Wisconsin Center for Applied Microelectronics (WCAM) and the UW Materials

Science Center (MSC). The shared facilities serve internal and external users in academia and in industry.

For further information about this project link to **www.nsec.wisc.edu** or email **nealey@engr.wisc.edu**