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BIO-DERIVED ELECTRONIC AND PHOTONIC POLYMERS

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An alternative, biocatalytic approach to the synthesis of new electrically conducting and optically active polymers is presented. In this approach, biocatalytic polymerization is carried out in the presence of ionic templates to yield water-soluble complexes of the polymer and the template used. Here the template provides a preferential local environment, which serves to emulsify the monomer prior to polymerization, promote head to tail coupling of the monomer and complexes to the polymer formed to maintain water solubility. In the case of electronic polymers, the template also serves to dope the polymer to the electrically conducting form. This approach is particularly attractive in that it is simple (one step), uses very mild reaction conditions, requires minimal separation and purification, and results in a processable form of the polymer. In addition the process is general as numerous ionic polymers and surfactant templates may be interchanged to build in desired functionalization.

This talk will cover recent results with the versatility of this bicatalytic approach to synthesize a wide variety of processable electronically conducting and photonic polymers using various monomers, templates and biocatalysts. Also the potential use of these materials in various DoD and commercial applications such as sensors, electrochromic and optical devices and organic based solar cells will be discussed.

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+ This work is dedicated to the memory of Sukant Tripathy

The mildness of this approach also allows for the utilization of more biological templates, such as DNA. A discussion of these reactions including characterization, versatility, electronic and optical properties and applications of these materials to DoD and commercial applications will be presented. The assembly of electronic and photonic materials on biomacromolecules is of tremendous interest for the development of biofunctional nanocomplexes as well as highly selective biosensors. Recently, we have reported an enzyme catalyzed synthetic procedure involving horseradish peroxidase (HRP) for the polymerization of aniline on a calf thymus DNA matrix. The mild reaction conditions involved in the synthesis have provided opportunities for the use of these more delicate biomacromolecules as templates. Circular dichroism polarimetry and UV-vis spectroscopic studies show that electroactive polyaniline is formed and intertwined with the DNA. The secondary structure of the DNA may be reversibly controlled from the native form to an overwound polymorph by simple changing the redox state of the polyaniline.

This approach is versatile and may be extended to numerous other biological polyelectrolytes and monomers to yield responsive biomacromolecular complexes for the development of biosensors, nanowires and diagnostic tools.

(C) With the increased sophistication of weaponry and systems for survivability and effectiveness, such as telecommunications and sensors, today's soldier must have portable electrical power. Today, this power is provided by batteries, often heavy, dangerous, detectable and always of finite capacity. Dependence on batteries limits the soldiers' capabilities and may compromise their ability to succeed and survive. Solar cells may offer the soldier a highly effective, self-sufficient, low signature and versatile source of power if they are made to be lightweight and conformal. The Army currently has a program to develop these types of devices. The core technology is based on new light-harvesting dyes that are adsorbed onto titanium dioxide nanoparticles. Spin coating, electrostatic layer-by-layer deposition and electrospinning have been used to fabricate ultrathin photovoltaic devices. This PV technology may eventually be integrated into soldiers' uniforms, electronics and weapons or may be carried by the soldier as a roll to be extended over a large area to provide great power throughout the duration of a mission. Obvious extensions of these technologies will include solar cells for tentage materials in shelters and on vehicles. Recent developments in this program will be presented.