Presentation Abstract:

Novel Biopolymers and Their Potential Applications as Environmentally Friendly Adhesives, Coatings and Structural Materials.

Douglas C. Hansen

The understanding and control of the interaction of polymers with solid surfaces is important in fields as varied as biomedical engineering, pharmaceuticals, biotechnology and cell culture, biofouling and corrosion electrochemistry. Compounds that fill the role as adhesives and structural materials in nature in both plants and animals are coming under increasing scrutiny by researchers as potential replacements or models for synthetic adhesives, polymers and composite materials presently in use. A wide variety of organisms (mollusks, tunicates, marine algae, bacteria) routinely rely on polymer chemistry to manufacture these adhesives, protective coatings and structural materials. These biopolymers contain a unique amino acid, namely L-3,4-dihydroxyphhenyl-L-alanine (L-Dopa). A particularly intriguing manufacturing process, referred to as sclerotization, is a hardening process in certain organic plant and animal structures. This occurs via the cross-linking of these polymers involving L-dopa in the presence of a companion enzyme. Biomaterials manufactured in this way are some of the most robust known in nature; after curing, these structures are insoluble in water, detergents, protein denaturants, organic solvents, and cold, dilute or concentrated acids and bases. Another unique property of these L-dopa containing biopolymers are their extremely high affinity for binding and complexing of metal ions. This allows for the adsorption (sometimes irreversible) of the polymers to metal surfaces (thus making them excellent adhesives).

Research in this area by my group here at UD has been funded by the Air Force Office of Scientific Research (AFOSR) and the Office of Naval Research (ONR) over the years in an effort to determine the chemical interactions of these biological polymers with metal surfaces towards developing environmentally friendly corrosion inhibitors, biomimetic structural materials (bioceramics) and coatings. Biotechnological applications of L-dopa polymers have been proposed, yet little is known of their chemistry with regard to their interactions with surfaces. The development of genetically engineered polymers with metal-binding properties will provide an environmentally friendly, renewable resource that has many biomedical, aerospace, naval and industrial applications. Such potential applications include: antifoulants, medical adhesives and coatings, dental adhesives and fillers, microencapsulating agents, metal scavengers/detoxicants, and new polymeric-composite materials.

This research presents a multi-disciplinary approach to the study of biological polymers and their biochemistry and material properties. The basic research involving the isolation and characterization of these biopolymers, along with the applied research challenges focusing on novel biotechnological, structural material and bioelectrochemical continues to provide new areas of cross-disciplinary collaboration within and outside of UD as well as serve to educate and challenge the students within the biology/chemistry/materials science programs.