ENZYME-NANOMATERIAL CONJUGATES: OPPORTUNITIES FOR FUNCTIONALLY ORGANIZED MATERIALS

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Key words: Biocatalysis, Nanoscale composites; Antifouling surfaces

Introduction. The interface of biology and materials science has led to new materials with unique structural and functional properties, and new process technologies. These materials and their designs have broad application as catalysts, sensors, and devices for use in synthesis, cell and tissue engineering, and bioanalysis and screening, and nanoelectronics. We have focused on gaining a fundamental understanding of protein-nanomaterial interactions. During these investigations, we have uncovered a remarkable effect of molecular curvature that strongly enhances protein activity and stability. Specifically, experiments involving protein-containing single-walled carbon nanotubes and buckyball aggregates, along with an associated theoretical analysis, reveal that the observed enhancement in protein stability is a direct result of the extreme surface curvature of these nanoscale materials, which suppresses unfavorable protein-protein interactions. The ability to enhance protein function by interfacing them with nanomaterials will have a profound impact on applications ranging from biosensing to self-cleaning and healing materials to drug discovery. For example, we have exploited this stabilization phenomenon coupled with the unique architectures of nanoscale biological-material hybrids to design enzyme-containing conjugates and composites that are functional in environments that are often denaturing to proteins, such as surface active paints and coatings. In this manner, we have been successful in generating surface-active materials that possess anti-protein binding and antimicrobial activity.

Acknowledgements. This work has been funded by the National Science Foundation (Nanoscale Science and Engineeering Center) and the National Institutes of Health (Institute of Dental and Craniofacial Research).

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