THE EFFECT OF GOLD NANOPARTICLE STRUCTURE ON THE CONFORMATION AND FUNCTION OF ADSORBED PROTEINS

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A Thesis Submitted to the Graduate

Faculty of Rensselaer Polytechnic Institute

in Partial Fulfillment of the

Requirements for the Degree of

DOCTOR OF PHILOSOPHY

Major Subject: MATERIALS ENGINEERING

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April 2012
(For Graduation May 2012)

ABSTRACT

Many applications of nanobiomaterials rely on or are enhanced by specific, protein-mediated interactions with biological systems. These interactions can be engineered by chemically modifying the surface of the material to affect protein adsorption, or by altering the topography of the nanoscale surface. The attachment or adsorption of proteins onto materials can greatly affect the structure and subsequent function of those proteins, giving rise to unpredictable and potentially undesirable effects. Thus, it is essential to develop a detailed understanding of how nanostructured surface characteristics, such as atomic-scale topography, surface energy, and chemical structure may affect protein adsorption, structure, function, and stability.

The presented work on gold nanoparticles (AuNP) in the forms of spheres (AuNS), rods (AuNR), cubes (AuNC) and octahedra (AuNO) will elucidate the effect of nanoparticle morphology on adsorbed model proteins lysozyme (Lyz) and α-chymotrypsin (ChT). It has been found that nanoparticle morphology does affect the structure of adsorbed proteins as well as the extent of the surface coverage; however, the final form of the nano-bio conjugate is protein specific. Lyz conjugates underwent loss of structure and rapid aggregation regardless of AuNP morphology; however, ChT conjugates exhibited no structure loss when immobilized on AuNS, and a significant, loading specific structure loss when adsorbed on AuNR. Further work will be presented on efforts to determine the role of crystal structure, surface energy, and ligand chemistry on adsorbed proteins. Wet chemical methods are used to synthesize AuNC with {100} facets and AuNO with {111} facets. Nanoparticles are characterized through electron microscopy, X-ray and electron diffraction, X-ray photoelectron spectroscopy and inductively coupled plasma mass spectroscopy. Protein conjugation and changes in protein structure are monitored through a variety of physical and spectroscopic techniques.

Although many current studies have focused primarily on exploiting nanostructured material properties for biomedical applications, insufficient identification and understanding of key variables involved at the protein-nanomaterial interface hinder the development of these technologies. Fundamental understanding of how nanomaterial properties affect protein structure and function will assist in the strategic engineering of protein-nanomaterial conjugates for a variety of important biomedical applications.