Protein-resistant Polymers for Advanced Biomaterials

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Background

The non-specific adsorption and accumulation of proteins on surfaces, or protein fouling, is a chronic problem that affects many fields. One area where fouling remains a problem is in membrane-based water filtration systems. The accumulation of proteins and related biofilms on porous membranes leads to a rapid decrease in



water flux, operating performance, and lifetime, which mandate regular membrane replacement or cleaning. Such adverse effects are especially important in the performance of membrane-based water reclamation systems such as membrane bioreactors. Current methods to mitigate this issue have inherent disadvantages for implementation, such as introducing additional chemicals onto system, intensifying system maintenance requirements, or requiring more complex automation and control system for the membranes.

Another area where protein adsorption has historically been a major concern is the biomedical device area. The adsorption of proteins in biomedical arena has been known to cause discomfort to the patient, decrease drug activity, or lead to an undesired medical condition, such as inflammation or an unwanted immune response. The applications of non-fouling surfaces in medical devices are multiple and include prostheses, drug delivery devices, sensors, substrates for enzyme-linked immunosorbent assays, materials for use in contact lenses, and implanted devices.

Certain functionalized polymers have been found to resist the adsorption of marine fouling organisms, microbes, and proteins. However, most of these materials are either not hydrophilic, chemically stable, or cost-effective enough to be suitable for water filtration membranes. There is a clear need to develop new types of coating materials with the intrinsic ability and chemical properties to resist protein adsorption.

Technology

A University of Colorado research group led by Douglas Gin, in collaboration with the University of Texas, has discovered a new type of functional polymer membrane coating that resists fouling. By cross-linking quaternary phosphonium- and ammonium-based polymer coatings, the researchers have developed polymers that exhibit protein-adsorption resistance properties on par with, or better than, polymers containing poly(ethylene oxide), which is the current benchmark functional group for protein-resistant coatings. The new protein-resistant polymer functional groups described in this invention are readily synthesized, water-compatible, and chemically stable with respect to hydrolysis, acid attack, base attack, oxidation, and reduction. Although these new coating materials have most relevance in the context of protecting water filtration membranes against protein accumulation, they can also be applied to other types of materials in contact with protein-contaminated water to resist protein adsorption and have possible applications in the biomedical industry as well.



Key Documents

Polymer Coatings That Resist Adsorption of Proteins. U.S. regular application filed 9/21/09.

New protein-resistant coatings for water filtration membranes based on quaternary ammonium and phosphonium polymers. Jour. Mem. Sci. 2009;330(1-2):104-16. PDF available upon request.