SEARCH FOR PROTEIN-RESISTANT POLYMERIC MEMBRANE SURFACES VIA PHOTO-INDUCED GRAFT POLYMERIZATION WITH A HIGH THROUGHPUT PLATFORM

by

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ABSTRACT

Surface modification is important in membrane processes for its ability to confer desired characteristics to existing membrane materials. Conventional hypothesis-driven methodology of searching and testing novel membrane surfaces is slow and relatively labor-intensive by having to synthesis and analyze surfaces one by one. Here, we apply a high throughput platform (HTP) to photo-induced graft polymerization (PGP) method to prepare and examine many surfaces at one time.

The goals of research presented here are to use the HTP-PGP method to: (i) optimize experimental conditions of poly(ethylene glycol) (PEG) grafting to maximize protein anti-fouling properties, (ii) discover novel protein anti-fouling surfaces by expanding the library of grafting materials via initiation of chemical reactions at monomer-grafted membrane surfaces, (iii) discover novel protein-fouling resistant surfaces by expanding the monomer library utilizing epoxy-ring chemistry at the membrane surfaces, and (iv) search for novel substrates with high binding capacity for stem cell growth without differentiation.

Here, the HTP-PGP technique is applied to prepare and analyze 96 surfaces at once, ensuring fast analysis of membrane surfaces with excellent statistics. This would take months with a conventional low throughput synthesis and analysis approach.

Optimization of PEG grafting by mixing solvents in grafting solution increased protein fouling resistance. Mixing 0.1 mol L^{-1} PEG and 0.1 mol L^{-1} dichloromethane in the grafting solution resulted in the highest fouling resistance with $\Re = 0.03 \pm 0.04$. We discovered novel protein anti-fouling substrates by grafting poly(ethylene glycol) (PEG)

and amines simultaneously. Grafting 0.06 mol L^{-1} PEG and 0.14 mol L^{-1} N-vinylacetamide (NVA) showed the best fouling resistance against bovine serum albumin (BSA) with $\Re$ = -0.56 $\pm$ 0.29. Searching for novel protein-fouling resistant surfaces by expansion of the monomer library was performed by grafting glycidyl methacrylate and reacting amines with the epoxy group on the surface. Ethanolamine exhibited the lowest fouling for BSA feed with $\Re$ = 0.23 $\pm$ 0.11 and $\bar{q}$ = 0.50 $\pm$ 0.07, and diethanolamine showed the lowest fouling for lysozyme feed with A24, $\Re$ = -1.96 $\pm$ 0.26 and $\bar{q}$ = 0.71 $\pm$ 0.03. Also, mouse embryonic stem (ES) cells exhibited the best attachment without differentiation on 0.2 mol L^{-1} N-[3-(dimethylamino)propyl]methacrylamide-grafted surfaces by CAI = 2.2 $\pm$ 0.3 for CCE ES cells and 2.5 $\pm$ 0.8 for GFP ES cells.