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Desalination 200 (2006) 462–463

DESALINATION

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# Effects of photo-initiation and monomer composition onto performance of graft-copolymer based membrane adsorbers

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Received 28 October 2005; accepted 3 March 2006

## 1. Introduction

Photo-initiated surface-selective graft copolymerisation onto polypropylene (PP) microfiltration membranes is an improved method to prepare porous membrane adsorbers [1]. The potential versatility and economic value of this method motivated us to further investigate main parameters for control of membrane adsorber functionality. In this work we studied the influence of photo initiator concentration and entrapping time in the initiator immobilization step and of monomer solution composition in the photo-grafting step. Benzophone (BP) dissolved in heptane was used in the photo initiator coating step. The functional monomer acrylic acid (AA), the diluent monomer acrylamide (AAm) and the cross-linker methylene bisacrylamide (MBAA) were used to prepare grafted copolymer layers with weak cation-exchange groups in the second step. For the characterization we focussed on the degree of grafting (DG) via gravimetry, ATR-IR spectroscopy, membrane permeability as a function of solution pH and ionic strength and dynamic protein binding

capacities and recovery from membrane chromatography experiments. Using the membranes with best performance, the separation of protein mixture was also investigated.

## 2. Results and discussions

Photoinitiator immobilization should facilitate photo-initiated “grafting-from” the PP surface and thus prevent polymerization in solution and other side reactions. Immersion of the PP membranes in the BP solution in heptane and subsequent change to a polar solvent was expected to lead to “entrapped” BP close to the PP surface. Results of the variation of BP concentration between 0.01 and 1 wt% at constant conditions in the second step revealed that a concentration of 0.1 wt% yielded an optimum grafting efficiency. For a variation of photo initiator entrapping time between 15 and 60 min, the DG did not change much, but a period of 45 min yielded membranes with the highest permeability. All data demonstrate that not only the BP amount but also its distribution in the surface layer of the PP is important for the structure of the grafted polymer layers.

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*Presented at EUROMEMBRANE 2006, 24–28 September 2006, Giardini Naxos, Italy.*

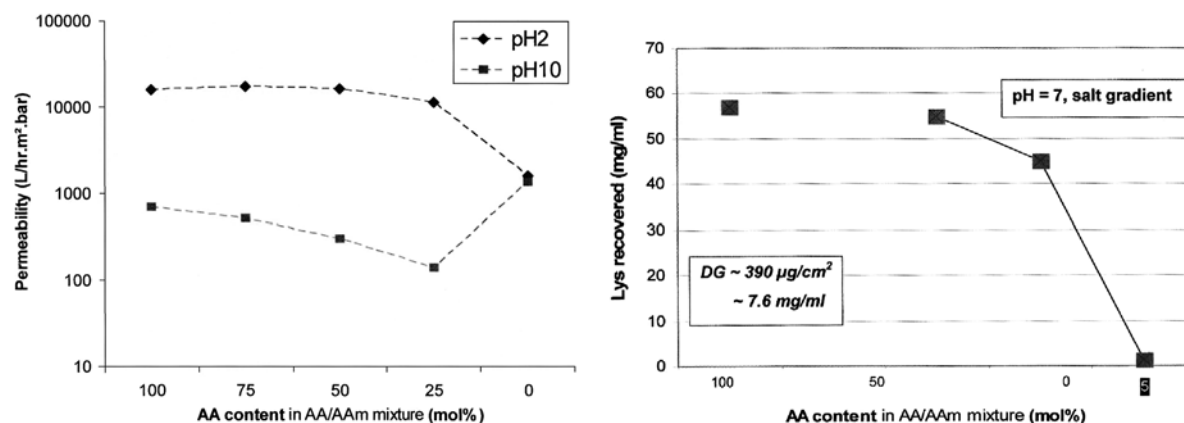


Fig. 1. Water permeability at different pH values and reversible lysozyme binding capacities for PP membranes ( $d_p \sim 0.4 \mu\text{m}$ ) functionalized with photo-grafted copolymers of AA and AAm in varied ratio.

Monomer variations had been performed with selected BP immobilization conditions and similar DG values had been adjusted by variations of monomer concentrations at constant UV irradiation time. Permeability data could be interpreted in terms of average grafted layer thickness and flexibility as function of pH and ionic strength. And those properties were also influenced by the BP entrapping conditions (cf. above). High reversible protein binding capacities could be obtained, and this data correlated with the information about grafted polymer structure deduced from the other characterizations (cf. Fig. 1).

The combination of AA and AAm with a low content of MBAA produced membrane adsorb-ers with reproducibly high capacities and very good protein recovery. The cross-linking of the functional polymer brush seemed to improve its integrity and stability.

### 3. Conclusions

The method for preparing graft-copolymer based membrane adsorb-ers is successfully opti-mized via the combination functional, diluent and cross-linker monomers along with optimal photo-initiator coating conditions. This will enable further investigations of the effects of process conditions such as, e.g., flow rate onto protein separation performance.

### Acknowledgement

AHMY gratefully acknowledges the grant of a Ph.D. scholarship by the Government of Malaysia.

### Reference

- [1] M. Ulbricht and H. Yang, Porous polypropylene membranes with different carboxyl polymer brush layers for reversible protein binding via surface-initiated graft copolymerization. *Chem. Mater.*, 17 (2005) 2622–2631.