Enzyme-catalyzed Modification of Poly(ethersulfone) Membranes

Norhan Nady[1,2,3], Maurice Franssen[2], M. S. Mohyeldin[3], Remko Boom[1], Han Zuilhof[2], and Karin Schroën[1]

Scope and targets

To investigate the *laccase-catalyzed modification of* polyethersulfone membranes, and to evaluate the behavior of the modified membranes.

Materials, Methods & Results

Various phenolic acids (enzyme substrates) were coupled under mild conditions to PES membranes (neutral pH, room temperature, aqueous medium) using laccase from *Trametes versicolor* as catalyst. The membranes changed color upon reaction, which could not be removed by washing (illustrated in Figure 1A and B). Figure 1C shows SEM pictures of layers that were formed, and IR-GIR (Figure 2) shows an increase in peaks attributed to covalently bound substrate (1708 cm^{-1} [C=O], 3200-3500 cm^{-1} [O-H]). The derived reaction mechanism is shown in Figure 3. Water flux measurements (Figure 4A) show that the flux is not influenced much by the modified layer, and protein adsorption (Figure 4B) is decreased. Under some conditions protein adsorption is even minimal.

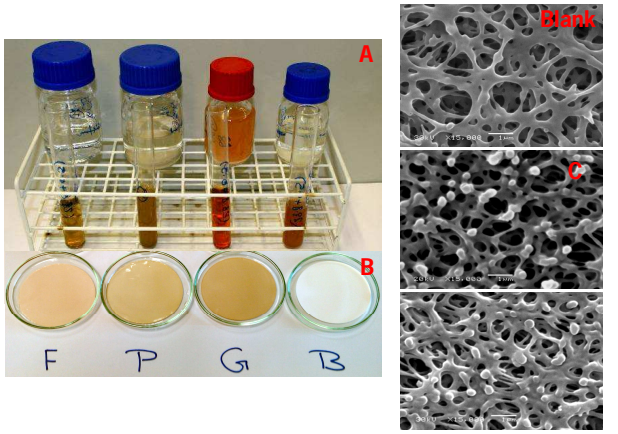

Figure 1. A) Color changes during reaction; vessels contain original solution, tubes liquid after reaction, and **B)** dishes with membranes modified with Ferulic acid [F], Para-hydroxybenzoic acid [P], Gallic acid [G] and the blank Sartorius membrane [B]. **C)** SEM images of PES membranes with grafted layers.

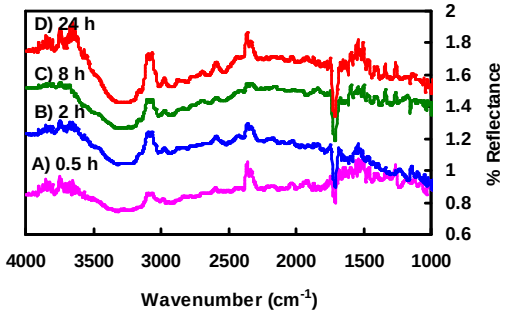

Figure 2. IR-GIR spectra for membranes grafted with 4-hydroxybenzoic acid [P] after 0.5 (A), 2 (B), 8 (C), and 24 h (D) incubation. Reflectance is relative to an unmodified membrane.

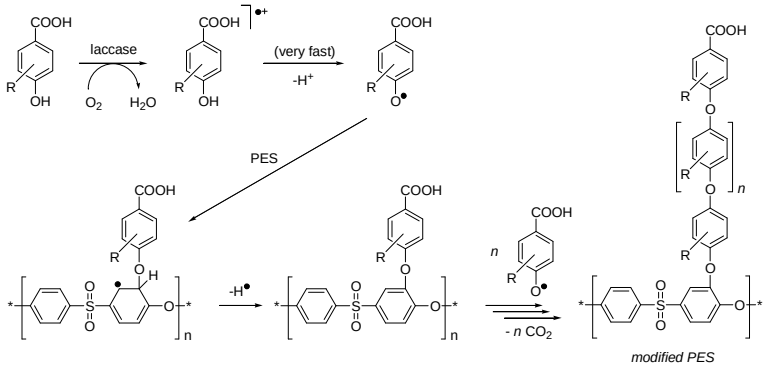

Figure 3. Proposed mechanism for formation of reactive phenolic acid radicals and grafting of the radicals to PES membranes.

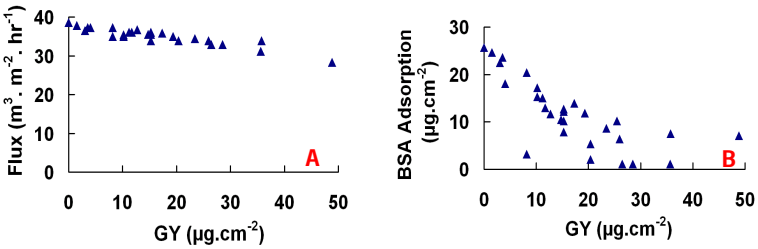

Figure 4. A) Clean water flux **B)** BSA adsorption, as function of grafting yield (GY).

Conclusions

Laccase-catalyzed modification of PES membranes can be carried under eco-friendly conditions and is suited for the preparations of ***high flux low protein fouling membranes.***

1 Food and Bioprocess Engineering group, Wageningen University, P.O. Box 8129, 6700 EV Wageningen, The Netherlands.
2 Laboratory of Organic Chemistry, Wageningen University, Dreijenplein 8, 6703 HB Wageningen, The Netherlands.
3 Polymers Department, Advanced Technology and New Materials Research Institute (ATNMRI), Mubarak City for Scientific Research and Technology Applications (MuCSAT), New Boarg El-Arab City 21934, Alexandria, Egypt.

Norhan.Nady@wur.nl