# Development of conducting polymer layers on membranes to prevent biofouling and enhance biocide effects

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## Aim

The aim of this project is to prevent and reduce biofouling on membranes and to remove any biofilms that have already formed. To achieve this, membranes are coated with conducting polymers e.g. polypyrrole (ppy), polythiophene or polyaniline, and the polymer layer is polarised. This polarisation inhibits biofouling and enhances the effect of biocides.
Conducting polymers can be modified as cation- or anion-exchangers and their porosity can be controlled to avoid any impairment of the membrane by the polymer coating.

This new method of preventing biofouling offers economic and ecological benefits compared to conventional methods because it avoids or reduces the use of biocides and thus prolongs the operating time of the membranes.
This project is worked on in cooperation with IWW in Mülheim / Ruhr.

## Production of the polymer coating

A coating technique for the deposition of conducting polymers on membranes was developed. The membrane is fixed in a cell. One compartment of the cell is filled with the monomer solution, e.g. pyrrole, and the other compartment is filled with an oxidant. The py monomers diffuse through the membrane (Fig.1A), and polymerise as ppy coating on the membrane when they reach the oxidant (Fig.1B).

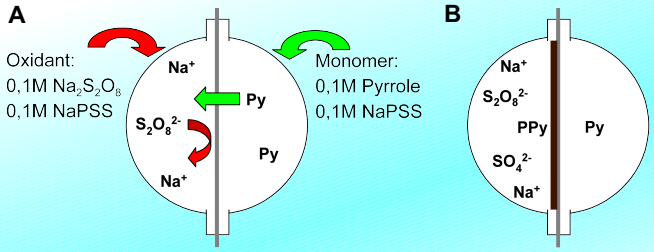


**Fig.1: Coatimg of a polystyrenesulfonate (PSS) membrane with ppy. A: Scheme and filling of the cell, B: Deposition of the ppy layer.**

Scanning electron microscopy (SEM) pictures in Fig.2 show a ppy layer deposited on a PSS membrane.

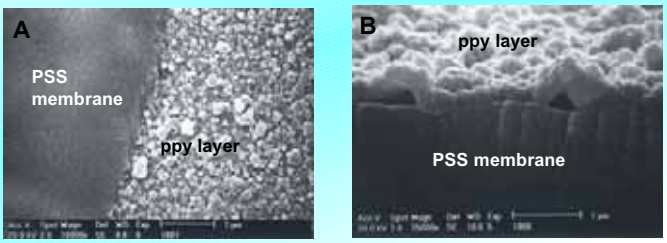


**Fig.2: A: Cross-section of a coated PSS-membrane, B: Topview of the coated membrane (the uncoated area of the membrane was covered by the flange of the cell during the polymerisation).**

Other membranes, such as cation- and anion-exchanger, ultrafiltration and reverse osmosis membranes, have also been coated with ppy.

## Characterisation of the ppy coating

Contact angle measurements show that the ppy coating increases the hydrophilicity of the membranes (Fig.3A and B).

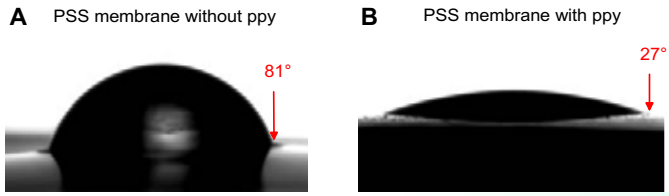


**Fig.3: Surface angle investigations of uncoated (A) and coated (B) PSS membranes.**

For electrochemical investigations of the coated membranes a holder with electric contact has been constructed (Fig.4).

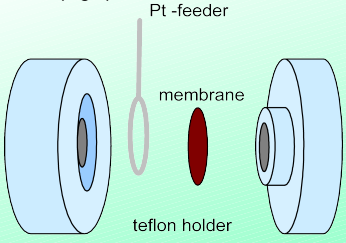


**Fig.4:Teflon holder with Pt-feeder for the electrochemical investigation of the membranes.**

Cyclic voltammograms show the strong increase of the electrochemical activity of the membrane caused by the ppy coating (Fig.5).

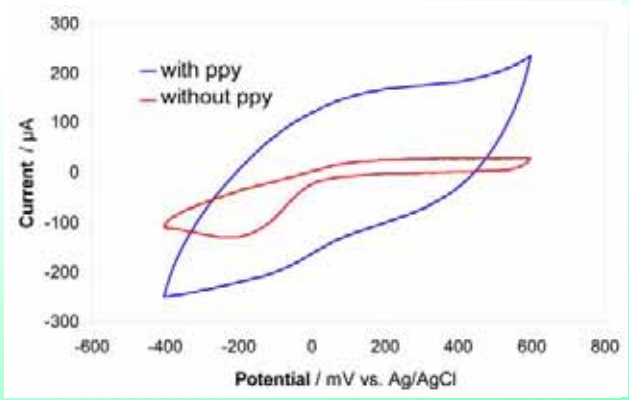


**Fig5: Cyclic voltammograms of coated and uncoated reverse osmosis membranes. 0,1M $Na_2SO_4$, v=10 mV $s^{-1}$.**

In further experiments the adhesion of microorganisms is tested on ppy coated membranes in dependence on different polarisation potentials.
A patent has been filed for the prevention of biofouling on membranes by conducting polymer layers.