Anti-fouling Membranes using Graphene Oxide

For resource efficient water treatment of the future

Background

Fouling is one of the major challenges in the membrane industry since it is associated with downtime, use of water and cleaning chemicals and reduction in membrane life.

The anti-fouling of polymer membranes by inclusion of GO has been demonstrated mainly for nano-filters. There is thus still a need to investigate if these promising results can be transferred to microfiltration.

The Idea

Inclusion of Graphene Oxide can

- ✓ increased hydrophilicity,
- ✓ optimized pore size and mechanical properties,
- ✓ provide negative Z-potential to reject major fouling component such as
  - extracellular polymeric substances (EPS) and
  - microorganisms

Variables

In our study we have been investigating

- 4 different GO and GO derivatives
- 3 solvent
- 2 different types of dispersant/spacers for the GO
- 4 different PVDF polymers
- 3 different PVDF concentration
- 4 different GO/spacer ratios

Initial Evaluation

Quality of GO dispersion
Polymer blend viscosity
Pore size, aiming at a mean pore size of 0.25 µm

Results

Streaming Potential

The streaming potential for the different membranes was negative above pH 2.5, and decreased with higher pH.

The pure PVDF is highly negatively charged in itself, thus addition of GO or related materials is not important for the charge of the PVDF membrane. However, for commercial PVDF dopes this could be different.

Dead End Filtration

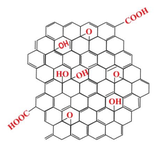
IVL has tested the membranes on incoming municipal effluent from 'Hammarby Sjöstadsverk' wastewater plant, pre-filtered with a 10 µm cartridge filter.

The tests were carried out at 2.0 bars of pressurized clean water and in a stirred so-called Amicon-cell with a cross-sectional diameter of 44 mm and a total volume of 70 ml.

COD has been analyzed before and after the filters, determining the rejection.

- ✓ For the best GO and GO derivative containing membranes were similar in rejection, but somewhat less flux.

Graphene Oxide



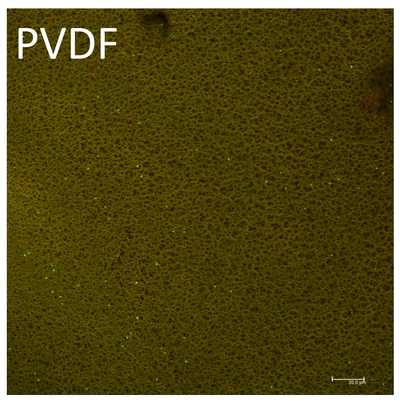
Anti-fouling

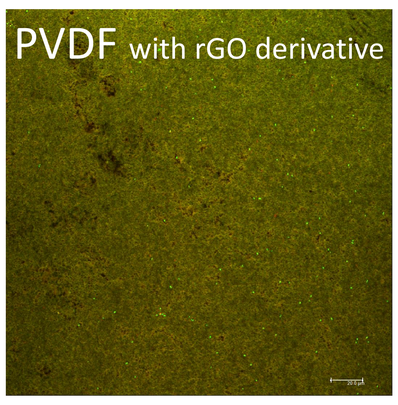
Preparation

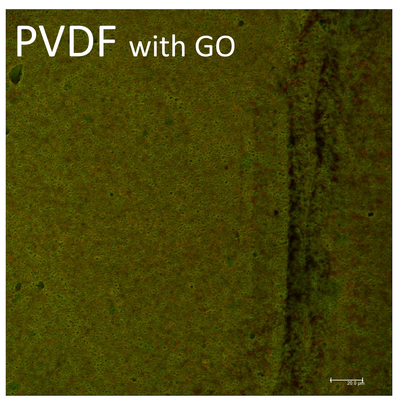
Pseudomonas aeruginosa (ATCC 10145)
6 days exposure of membranes using a beaker with magnetic laboratory stirrer at 37°C incubator. The bacteria solution was left to circulate at a moderate speed to build a biofilm on the membranes.
After dismounted membranes they were washed in 0,1% pepton water and stained with LiveDead staining prior to examination with a confocal laser scanning microscope.
Live bacteria are shown in green and dead bacteria are shown in red.
The membrane appears in yellow/green.

Result

PVDF with GO seems to have less bacteria on the membrane surface after 6 days exposure of *Pseudomonas aeruginosa, than the PVDF reference and the membrane with a reduced GO (rGO) derivative*.







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Future Plans

Long term testing using cross-flow filtration.

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