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www.elsevier.com/locate/memsci

PII: S0376-7388(17)33367-7
DOI: https://doi.org/10.1016/j.memsci.2018.03.037
Reference: MEMSCI16031

To appear in: *Journal of Membrane Science*

Received date: 28 November 2017
Revised date: 1 March 2018
Accepted date: 15 March 2018

Cite this article as: M. Barth, M. Wiese, W. Ogieglo, D. Go, A.J.C. Kuehne and M. Wessling, Monolayer microgel composite membranes with tunable permeability, *Journal of Membrane Science,* https://doi.org/10.1016/j.memsci.2018.03.037

Available online at www.sciencedirect.com

ScienceDirect

Journal of Membrane Science 00 (2018) 1–31

J. Mem. Sci.

Mem. Sci.logo

Monolayer microgel composite membranes with tunable permeabilitysize exclusion

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Abstract

Membranes with tunable gating functionality can be produced by modification with thermo-responsive polymers and colloids. We propose a straightforward method to gain this responsiveness by adsorption of microgels to the membrane surface. To be able to predict the filtration properties of the resulting composite membrane, a comprehensive understanding of the behavior of adsorbed microgels on porous substrates under convective flow is required. PreviousCurrent studies focus on constant pressure experiments at various temperatures neglecting changes in viscosity and flux. In this study, we investigate the permeability and selectivity of poly-*n*-isopropyl-acrylamide (PNIPAM) monolayer microgel membranes under convective flow in cross-flow mode applying a constant flux. We use in-situ spectroscopic ellipsometry on a porous substrate to prove a reproducible and confluent monolayer microgel deposition. Supporting scanning electron micrographs and confocal laser scanning micrographs confirm the high reliability of the ellipsometry data set.Using scanning electron microscopy, in-situ ellipsometry and confocal laser scanning microscopy we prove a reproducible and confluent monolayer microgel deposition on top of the substrate in dry and wet state. The monolayer microgel membranes show distinct switching between 25 and 50°C. When increasing the temperature above the microgel's volume phase transition temperature, the molecular weight cut-off (MWCO) of the functionalized membrane shifts to lower molar masses controlling the dextran retention between 30% and 70% only when the pore size of the support is in an appropriate range. The confluent monolayers are also mechanically stable when backwashed. Our data give insight into the responsive behavior of the PNIPAM network under convective flow – a key issue for custom-made filtration tasks.At this stage, it remains unclear whether the MWCO tracer molecules (a) mainly pass through the loosely crosslinked microgel periphery or (b) the microgels have tight intermicrogel junctions and the tracer molecules permeate through the whole microgel layer.

Keywords: thermo-responsive PNIPAM microgels, monolayer, temperature dependent MWCO, tunable permeability, in-situ ellipsometry

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