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Prof. Dr. Mathias Ulbricht

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Polymer-brush coatings for membrane fouling resistance – Towards theoretical design criteria

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Recent years have seen many efforts extended towards mitigating fouling through membrane surface modifications. Impressive progress has been made in this direction, involving surface coatings, deposition of nanoparticles and nano-structuring of membrane morphology through polymer grafting. The capacity for fouling resistance appears to rely on chemical functionality (normally ascribed to producing more hydrophilic membrane surfaces), reactivity (e.g. biocidal nanoparticles), physical repulsion (entropic resistance of a polymer brush layer to changes in its conformation/concentration) or a combination thereof. In particular, the case of polymer brush-coated membranes appears to be promising in the sense that it provides a protection layer to which additional functionality may be added; a great example of this are stimuli-responsive brushes. However, beyond empirical evidence showing indications of enhanced fouling resistance, what makes surface modifications perform better or more efficiently is not well understood.
Here, a theoretical attempt is made to rationalize the design criteria for efficient polymer brush layers that serve as a barrier, protecting membranes from fouling by colloidal matter. An augmented hydrodynamic theory for the permeation-induced 'drag' is presented, where attractive viscous forces are opposed by a repulsive force emerging from the compression of a brush layer upon the approach of a particle. The compressive force is discussed in relation to the polymer brush properties, e.g. chain length and rigidity, graft density and solvent compatibility. The ultimate goal is to create a theoretical link between controllable parameters of polymer brush, namely its chemistry and physical structure, and its capacity for providing an efficient protective functionality at given operating conditions.

Gäste sind herzlich willkommen!