
## Prof. Dr. Mathias Ulbricht

(UDuE, Germany)


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# Stimuli-responsive polymeric materials


Mathias Ulbricht
Lehrstuhl für Technische Chemie II, Universität Duisburg-Essen, 45117 Essen, and
CeNIDE – Centre for Nanointegration Duisburg-Essen, 47057 Duisburg; Germany
E-mail: mathias.ulbricht@uni-due.de


Stimuli-responsive responsive polymers are an interesting class of materials with many (potential) applications. Their common feature is that a chemical or physical stimulus (e.g., the presence of a chemical substance or an electromagnetic field) leads to large and reversible changes of properties. First, an overview on materials structures, switching principles and resulting functions will be given. An example from own work for a sensor system which is based on the swelling pressure of a responsive hydrogel will also be presented.

Thereafter, the focus will be on polymeric membranes where stimuli-responsive hydrogel layers or volume structures change the membrane surface properties or barrier structure [1]. Of interest for porous barriers is the interplay between pore size of the base material and extent of thickness or volume change, i.e., a typical response of hydrogels which are sensitive to changes of temperature, pH, the presence of certain ions or molecules, etc. This behavior can be used to reversibly change the barrier properties of a porous membrane; resulting functions are gated membranes, or ultrafiltration membranes with tunable pore size. The responsive behavior can, however, also be used to improve the cleaning efficiency of membranes; this relies on the reversible change in swelling / mobility of intrinsically low-fouling, "protective" functional hydrogel layers on the membrane surface.

We have systematically investigated such systems based on track-etched capillary pore membranes with base pore diameters between 10 µm down to 30 nm, in combination with various surface-initiated grafting or pore-filling techniques (e.g., [1-3]). We will present examples for temperature-responsive ultrafiltration membranes with efficiently switchable permeabilities and size-selectivities based on the well-known poly(N-isopropylacrylamide) (PNIPAAm) as grafted layer or pore-filling hydrogel. We will also demonstrate that such membranes can be made responsive to "remote control" by an external electromagnetic field by using co-immobilized superparamagnetic nanoparticles as local heaters within the pores. Molecular imprinting during *in situ* polymerization of PNIPAAm-based hydrogels in combination with pore-filling can be used to tailor membranes where the permeability is modulated by the presence of certain molecules, e.g., specific proteins. Beyond such studies with model base membranes, examples for the functionalization of industrially established polymeric base materials toward switchable separation membranes will also be discussed (cf., e.g., [4,5]).

**References**


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