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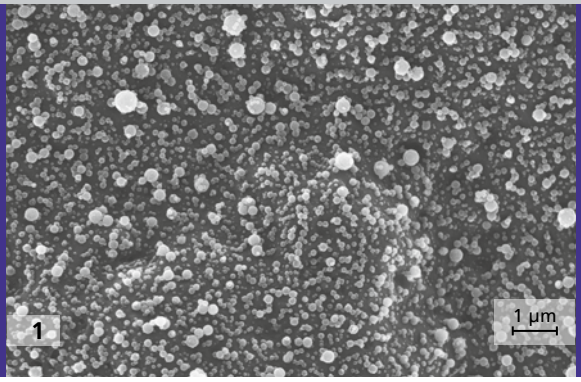

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1 *Scanning electron microscope (SEM) image of polymer adsorber particles.*
2 *Packing materials coated with adsorber particles.*
3 *Adsorption column.*

NANOCYTES® – SYNTHETIC ADSORBERS FOR THE REMOVAL OF ENVIRONMENTAL POLLUTANTS

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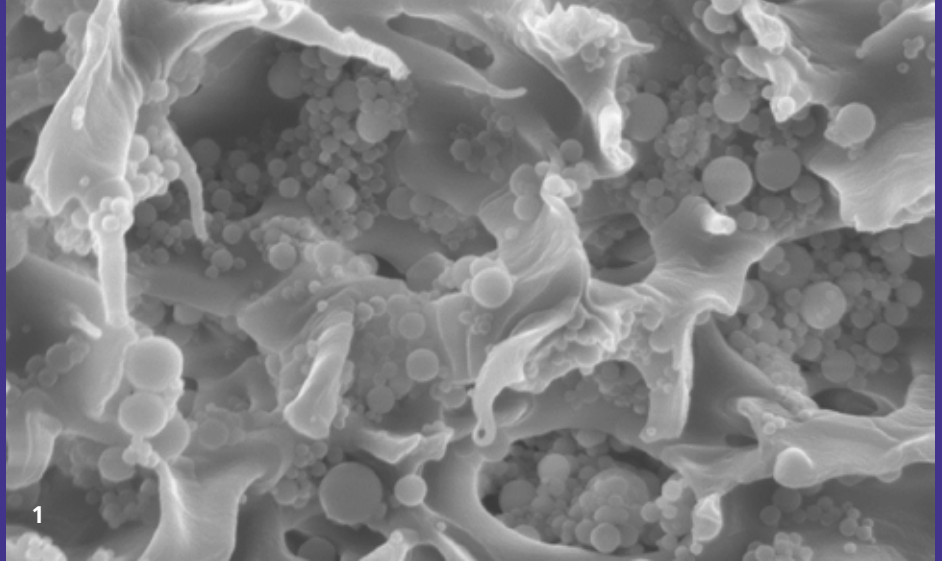
Water provides the basis for all forms of life on earth, and the state of human health depends entirely on water which is clean and hygienically safe for use. However, in recent years more and more hormonally active (endocrine) substances have been found in the environment. Endocrine active substances interfere with the hormonal systems of humans and animals, and can have negative effects on their health, especially in connection with reproductive disorders. Diluted in wastewater, these substances reach our purification plants where it is difficult or almost impossible to degrade them effectively even in the biological stages of treatment. Trace substances have already been found in drinking water.

This situation gave researchers at the Fraunhofer IGB the idea of producing selective adsorbers for the removal of endocrine active substances. These compounds include alkyl phenols in industrial detergents and shampoos, polychlorinated biphenyls (PCB) in seallants and hydraulic oil as well as bisphenol A which the plastics industry, in particular, uses in large quantities. Bisphenol A (BPA) has an estrogenic action and has been detected in the sewage sludge of German communal purification plants, in landfill leachate and also in drinking water. To improve this situation, the Fraunhofer IGB developed both nano and microstructured synthetic adsorber polymers to deal with the widely used bisphenol A. For the treatment of wastewater from hospitals and geriatric centers with high concentrations of medical substances, the polymer particles can be adapted to fit penicillin G (PEN G), pentoxifylline, diclofenac and antibiotics in the clarification step.

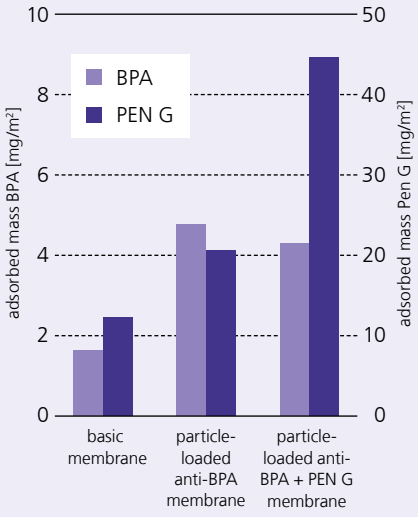


1 *Mixed matrix membrane: SEM image of the inner structure of a polyethersulfone (PES) membrane with embedded polymer adsorber particles.*

Specific adsorber polymers

In order to produce polymer nanoparticles for use as specific adsorbers, a polymerizable mixture consisting of one or more functional monomers together with a crosslinker is especially adapted to suit a target molecule. The mixture is then transformed into small nanoscopically sized polymeric adsorber beads (SPAs, specific polymer adsorber particles).

Adsorption of BPA and PEN G.



- Feed concentration BPA 150 ppb
- Feed concentration PEN G 10 ppm
- Volume solutions 2 × 50 ml
- Solutions were provided separately
- Membrane area 15 cm²
- Trans membrane pressure 0.2 bar

Non-polymerizable target molecules can be added to the mixture (molecular imprinting) to increase the selectivity of the adsorber particles. These target molecules or templates act as molecular stamps. Once they have been removed from the polymer network after successful polymerization, they leave behind both specific spatial-physical and chemical imprints on the synthetic surface of the polymer nanoparticles.

The Fraunhofer IGB uses its NANOCYTES® technology to create specific adsorber polymer nanoparticles by means of miniemulsion polymerization with typical particle sizes ranging from 50 to 500 nm. This is a heterophase polymerization process in which two immiscible liquid phases are emulsified to become homogenous and stable under the influence of high shearing forces and by using surfactants and co-stabilizers. The nanodroplets produced from the monomer and the osmotic reagent then form nanoreactors in which the polymerization takes place. This results in polymer nanoparticles which are direct reproductions of the emulsion droplets in terms of size and morphology. In comparison with other popular methods for the synthesis of polymer nanoparticles, such as emulsion polymerization or precipitation polymerization, the technology patented by the Fraunhofer IGB (DE 10 2007 061 436, DE 100 31 859) has the advantage that synthesis, although complex, is effected in one stage with a quantitative yield, independent of the diffusion of the educts.

Technical applications

The nanostructured materials created with our NANOCYTES® technology can be used in a wide variety of processing stages e.g. dispersed in a liquid phase as a colloid or suspension, as a layer in a composite membrane, as a matrix on packing materials or embedded in a porous membrane. Our polymer particles can also be equipped with magnetisable cores to separate resource-loaded particles by means of magnetic separators.

The main advantages of these specific adsorber polymers (SPAs) are their high binding capacity and selectivity, high chemical and thermal stability, excellent regenerability and reusability for other cycles combined with cost-efficient production processes.

Overview of our services

- Development and synthesis of specific adsorber polymer nanoparticles
- Feasibility studies
- Surface coatings with nanoparticles
- Conception and manufacture of selective composite or mixed matrix membranes
- Characterization of separation properties
- Development of hybrid materials