Biobased and synthetic polymer-nanoparticles as functional materials for wastewater treatment and sensing

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Urban and industrial development is highly dependent on an abundant supply of clean water. Pharmaceutically active compounds (PhACs) and micropollutants, present in wastewater, surface water and groundwater pose as a threat for the quality of water supplies.

The need of sustainable and high capacity adsorber systems which can be regenerated is evident. For this purpose, we synthesized crosslinked Chitosan nanoparticles (ChiNPs) and characterized their adsorption behaviour. A second nanoparticle system was developed to serve as covalent immobilized sensitive layer in a sensor application for detection of micropollutants. To produce spherical, narrow distributed particles in the nanometer range an inverse mini-emulsion formulation was chosen in both cases.^[1]

Chi-NPs via inverse miniemulsion crosslinking technique:

This is a general approach investigating the use of ChiNPs for the remediation of wastewater. Commercially available Chitosanes with different molecular weights were used for the synthesis of different ChiNPs. Glutaraldehyde was used for covalent crosslinking of the biopolymer ^[2]. ChiNPs were characterized by DLS and SEM. Pure Chitosan of different molecular weights and the corresponding nanoparticles were tested via HPLC for their adsorption behaviour towards two micropollutants: diclofenac and carbamazepine. The results of these measurements showed a high adsorption capacity of micropollutant up to 300 mg/g for ChiNPs, whereas the pure bulk Chitosan showed a low capacity in the range of 50 mg/g.

Sensor-NPs via Inverse miniemulsion polymerization:

For a nanoparticle based sensor application a high selectivity of the polymeric material towards the target molecule is crucial. Spherical, narrow distributed particles with a mean size of 200 nm were synthesized. Adding the target molecule to the aqueous phase enhanced the selectivity of NPs by imprinting mechanisms. A water-soluble methacrylate monomer bearing a primary amino moiety was copolymerized with a suitable crosslinker. In following steps, the NPs were functionalized to obtain accessible azido groups on the particles surface. These azido moieties allowed a covalent immobilisation of NPs on the sensor surface, forming the desired sensor layer. This surface was brought in contact with aqueous media containing the target molecule. The amount of adsorbed target molecule was quantified with Reflectometric interference spectroscopy (RIfS) even in the presence of the decomposition products.^[3]

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