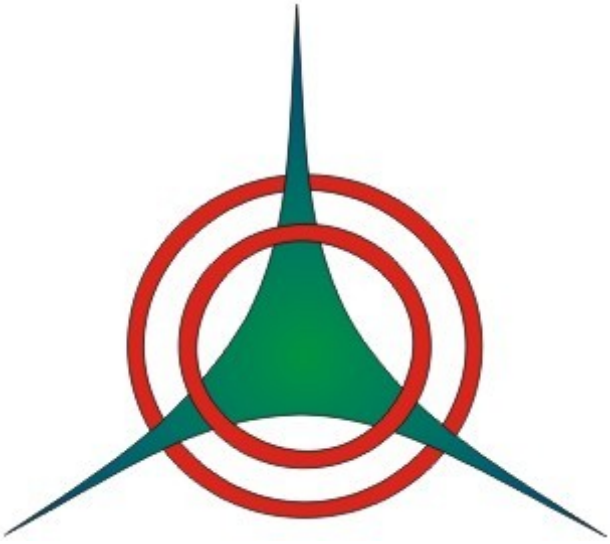
Healthcare industry BW

KIT - Competence in bioprocess engineering

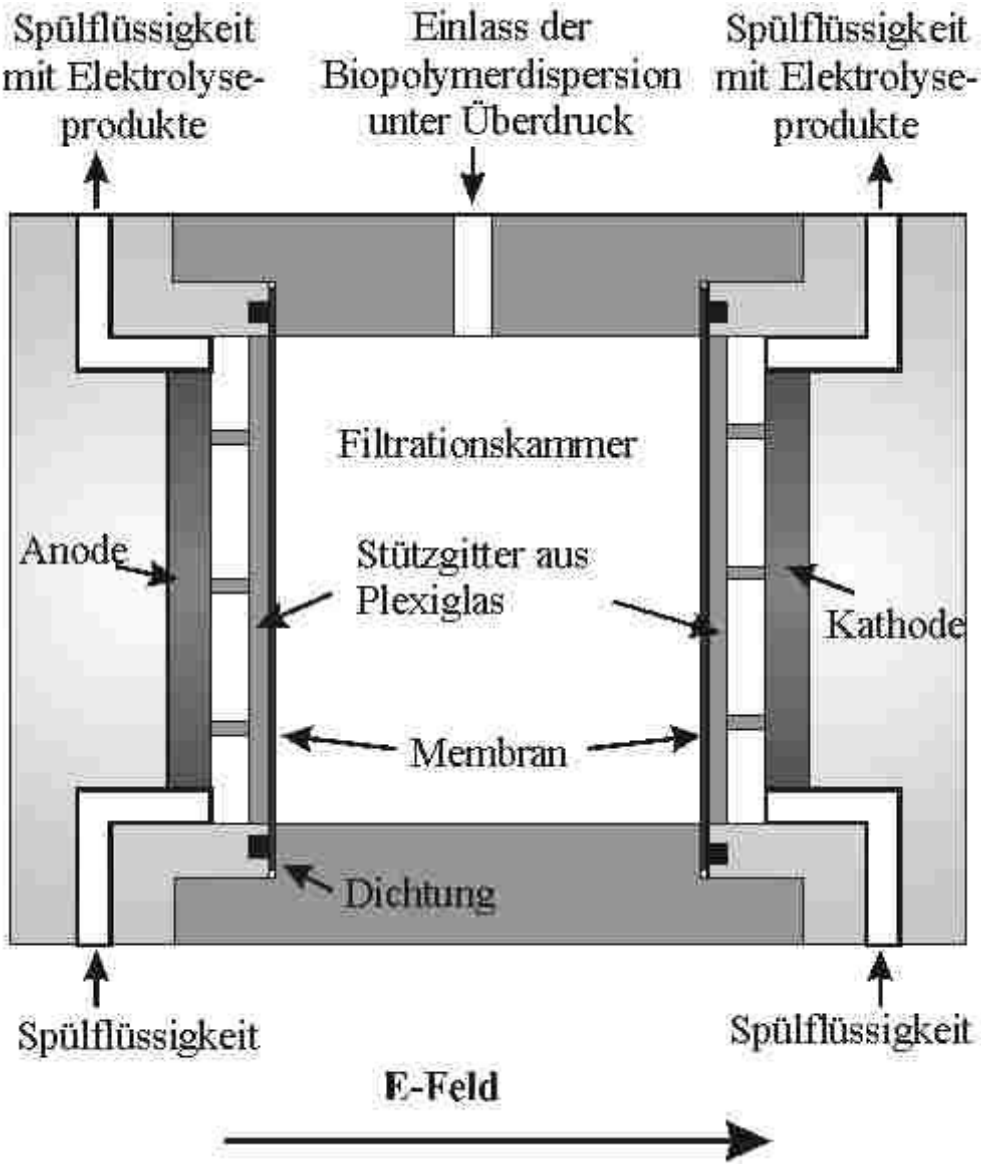
The purification of microbially produced substances such as proteins and polysaccharides and their separation from or release from within the cell are complex tasks in the field of biotechnology. The “Bioprocess Engineering” department of the Institute of Process Engineering in the Life Sciences (TH) deals with the development of integrated bioprocesses and is also involved in the separation of biopolymers.



Cells have been used as synthesis factories since the beginning of the last century. Xanthane (total production of 35,000 t in 2004) is a good example of the huge demand for microbiologically produced substances. In order to cater for such demand, scientists from the Bioprocess Engineering department are working on the improved production of biopolymers, polysaccharides and biomass (for the production of energy) from microorganisms (in particular microalgae) and mosses.

The major focus of the "Bio AG" work group led by Prof. Dr. Clemens Posten at the Institute of Process Engineering in the Life Sciences, centres on phototrophic bioprocesses (photobiotechnology) and particle biotechnology. The group has particular competence in the production (bioreaction) and the purification (downstreaming) of bioprocesses.

Purification of biopolymers



Schematic of the electrofiltration system.

One of the most frequent problems encountered in the biotechnological production of macromolecules is the low product yield. In order to increase the yield of the required product, Prof. Posten's work group uses improved mechanical separation techniques in the downstream area. Electrofiltration, which has been specifically developed for the separation of charged particles and biopolymers, is an excellent alternative to traditional purification methods. Press electrofiltration involves the application of an electrical field at the filtration chamber, which exerts its effect parallel to the direction of filtrate flow. If the electrophoretic force is higher than the hydrodynamic resistance, the charged particles move along the electrical field, resulting in a considerable reduction in the thickness of the filter cake on the membrane.

Press electrofiltration can be used for charged particles of less than a micrometer in size, i.e. polysaccharides, proteins and other biopolymers. Dr. Iris Perner-Nochta, one of the scientists in Prof. Posten's department, reports on the successful application of the technique in biopolymers: "We succeeded in producing concentrated microbiologically produced polyhydroxybutyrate (PHB) using electrofiltration." Inside the bacteria, the uncharged PHB granules are enclosed by a protein envelope and the scientists use this charge difference to separate PHB by way of electrofiltration, thereby enabling the purification of high PHB concentrations. This improved separation technology offers a broad range of applications in biopolymer research, which could also lead to advances in industrial

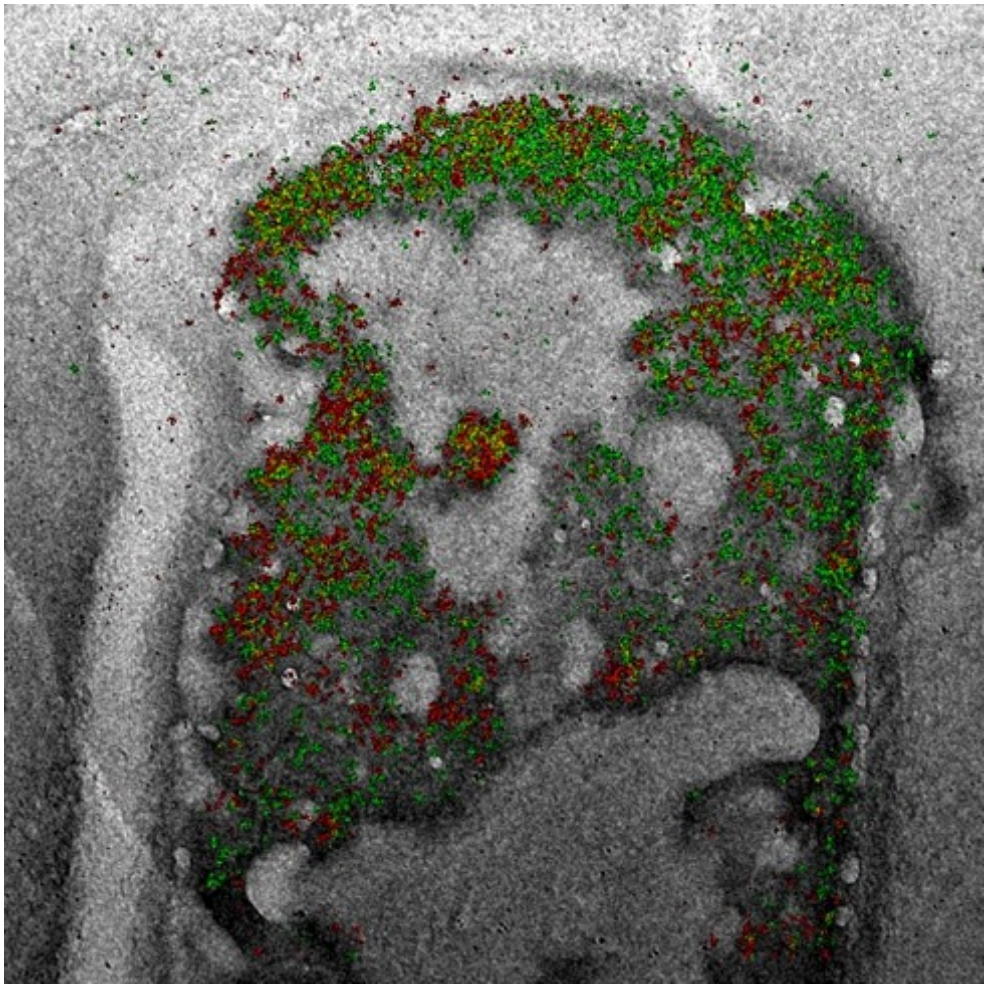
Electrofiltration of xanthane in the Symbiosis 250 pilot system: a thick xanthane layer accumulates at the anodal side of the set-up.

production.

Nanoparticles from yeast

Particle biotechnology has a lot more to offer, including the production of biogenic nanoparticles, another project Prof. Posten's team is working on. Dr. Iris Perner-Nochta and Dr. Nikolay Krumov are working on the isolation of cadmium sulphide nanoparticles produced by Schizosaccharomyces pombe. "In contrast to physico-chemically produced nanoparticles, the nanoparticles produced in yeast are all the same size," explains Perner-Nochta. "Time-consuming grading is therefore not necessary." In addition, the majority of nanoparticles form agglomerates and thus require a more sophisticated coating. In contrast, the nanoparticles produced using yeast have a peptide envelope that prevents the agglomeration of the particles. The cadmium sulphide nanoparticles might be used as quantum dots, tiny semiconductor crystals that are, amongst other things, used as LEDs or biological markers.

Improvement of the light yield



Electron microscope analysis of Schizosaccharomyces pombe (cadmium: red; sulphur: green). The Cd concentrations are so high that they would be toxic for the cells if they were not surrounded by a phytochelatin envelope.

Besides particle biotechnology, Prof. Posten's team is also focusing on photobiotechnology, which is the photobiotechnological production of hydrogen through microalgae and the development of innovative photoreactors based on the optimisation of the reactors' light yield. Although it is available in sufficient quantities, sunlight cannot usually be used by the algae since light saturation does not occur. In order to improve the light gain, the scientists are currently testing the use of light-guiding sponges to reduce the layer thickness of the algae suspension at the same as distributing the light to a larger inner surface. The scientists are now working to find out whether sponges could effectively be used in photobioreactors.

Article

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The article is part of the following dossiers

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