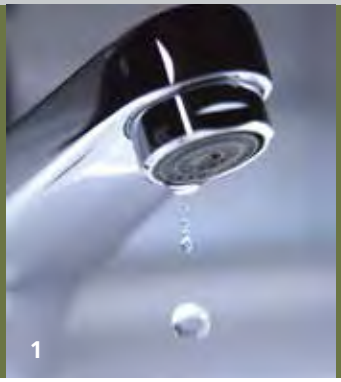
Fraunhofer
IGB

FRAUNHOFER INSTITUTE FOR INTERFACIAL ENGINEERING AND BIOTECHNOLOGY IGB


1


2


3

1 *Drinking water is the most important part of the human diet.*
2 *AquaBioTox demonstrator (Fraunhofer IOSB).*
3 *Reduction of fluorescence of biosensors as a response to toxic substances.*

BIOSENSORS AS ALARM SYSTEMS FOR DRINKING AND PROCESS WATER MONITORING

Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB
Nobelstrasse 12
70569 Stuttgart
Germany

Contact

Dr. Iris Trick
Phone +49 711 970-4217
iris.trick@igb.fraunhofer.de

www.igb.fraunhofer.de

Secure water supply and water treatment

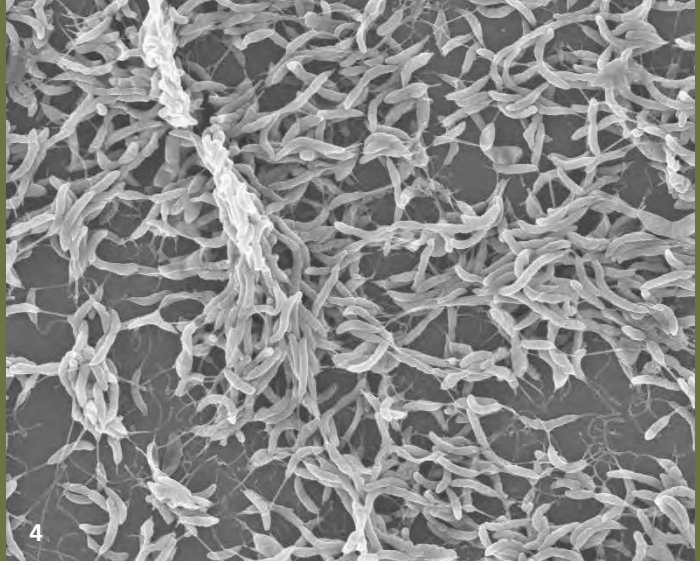
Clean drinking water is vital for humankind. Water pipes, however, are in permanent and unforeseeable danger of being contaminated. For example, repairs, industrial accidents or pesticides from farmland may result in groundwater contaminations entering the drinking water supply systems. In addition, decentralized and mobile drinking water supplies in particular constitute a potential target for criminal or terrorist attacks, e.g. through poisoning.

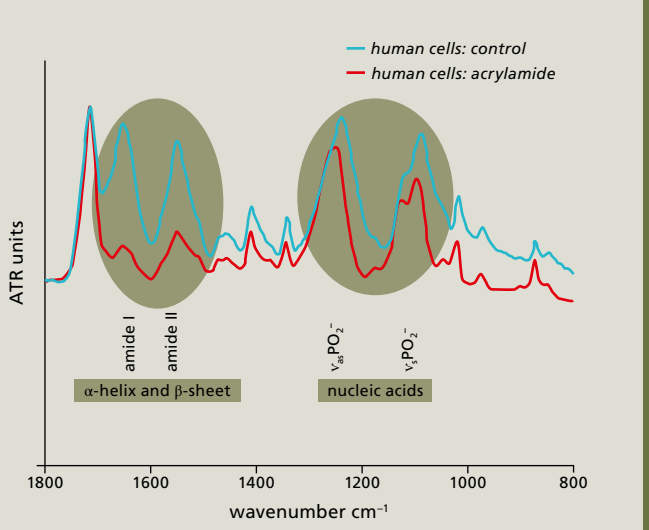
In order to prevent contaminated water from reaching the consumer, the drinking water in the distribution system has to be monitored constantly. After that, a quick response to the contamination with toxic substances is only possible if the analysis system is directly connected to the plant or the pipe system as an online measuring system.

In industry, the treatment of process water with chemical-physical processes is frequently required for a complete degradation of persistent or hazardous compounds. Biosensors are well suited to achieving a prompt and comprehensive monitoring of the purification process; these biosensors can be selected and adapted to meet individual requirements.

Biological sensors for detection of toxic substances

Biosensors consisting of living cells react quickly to the presence of toxic compounds and are, therefore, well suited for utilization in online alarm systems.





5

Advantages of biosensors

- In-situ monitoring possible
- Quick response of biosensors (reaction time < 5 min)
- Detection of toxic effect of chemical substances or biological toxins
- Transduction of alarm signal is based on reaction of biosensor

In order to determine the toxic effects of substances, we use mammalian cells and microorganisms as biological sensors integrated in suitable measuring cells. The biological cell types differ in respect to their metabolic properties, their cell structure, and their sensitivity to a variety of chemical substances and biological toxins.

Various measuring principles are being investigated to evaluate biosensor reaction. In the AquaBioTox system, fluorescent organisms are used as whole-cell biosensors and reduction in fluorescence as a response to the presence of a toxic substance is tracked quantitatively. In the Toxikomb system, alternative measuring methods are being developed. The system is based on the effects of hazardous substances on cell metabolism, on cellular constituents or at the molecular level and can also be used for supplementary measurements.

AquaBioTox – Toxin detection through reduction in fluorescence

Within a project funded by the German Ministry of Education and Research (BMBF) the Fraunhofer IGB, together with the Fraunhofer IOSB and two companies, has developed a whole-cell based sensor system using immobilized bacteria and mammalian cell lines in the measuring cell.

The genetically modified strains constitutively express a red fluorescent protein (RFP) which is measured optically by fluorescence detectors and a special camera system. Whenever the biosensor comes into contact with a toxin, the intensity of the fluorescence decreases. The sensitivity of the organisms was investigated with approximately 60 substances in different concentrations. Compared to other systems, a major advantage of the biosensors is their high reaction speed. A significant reaction is detectable in less than three minutes.

Dynamic experiments performed under laboratory conditions and in field tests were carried out using a demonstrator that is both robust and sensitive. This demonstrator integrates the supply of biosensors, the complete inactivation of the organisms in the event of a discharge and the optical measuring unit which includes PC-controlled management and documentation.

Toxikomb – Combined physical and biological sensor technology

In the Toxikomb system, which is being developed together with the Fraunhofer IAF, the aim is to detect toxic substances rapidly by measuring the reaction pattern of (genetically non-modified) organisms using electrochemical methods and infrared spectroscopy. Again, both microorganisms and mammalian cell lines are used as sensors.

The development of the sensor systems makes use of the fact that the biological activity of living cells is species-specifically impaired by cytotoxic substances. This either affects the interactions at interfaces (neighboring cells, material surfaces), or results in a measurable change to cellular components. These responses can be tracked by means of impedance measurement, since they have an influence both on the charges at the surfaces and on the spectrum of cell wall components and reaction products. For this purpose, the cells were immobilized on various electrode materials.

The method is supplemented by measurements using infrared spectroscopy (IR) which, on the one hand, permits the detection of chemical substances; on the other, IR highlights chemical effects on proteins, amino acids and nucleic acids. Measurements using infrared spectroscopy provide the proof of concept that cell components such as the protein structure of mammalian and bacterial cell systems change in a substance-specific way. Both measuring methods were successfully integrated into a measuring cell suitable for online monitoring.

4 *Growth of microbial biosensors on a carrier material.*

5 *Detecting the reaction of proteins and nucleic acids of human cells with acrylamide by infrared spectroscopy.*