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FRAUNHOFER INSTITUTE FOR CHEMICAL TECHNOLOGY ICT

ELEKTROCHEMICAL SENSORS

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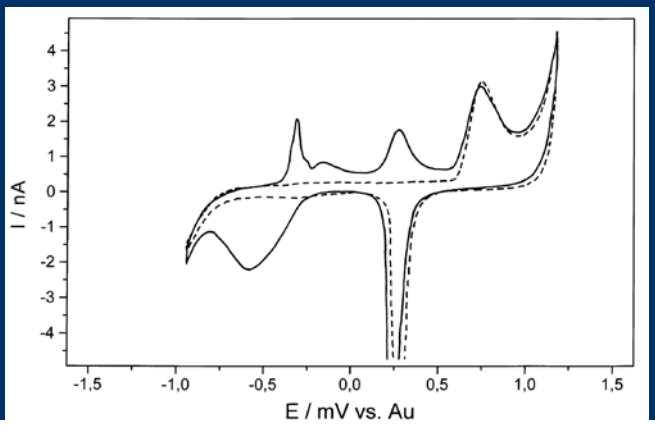


High sensitivity and simple construction

Electrochemical Sensors are currently applied in a wide range of sectors, including security, environmental diagnostics, process monitoring and medical technology.

The sensitive detection of low concentrations of substances (trace detection) is a particular challenge for the chemical sensors used in these sectors when rapid or on-site measurements are needed. Beside this requirement for sensitivity, high demands are also placed on the selectivity of the methods applied.

The advantages of electrochemical sensors over other types of sensors may include their high sensitivity, ease of use and low price. Many electrochemical sensors use amperometric measurement methods. Another established electrochemical method used in sensors is cyclic voltammetry. Unlike amperometric measurement systems, potentiodynamic systems based on cyclic voltammetry can provide qualitative as well as quantitative information. The Fraunhofer ICT has been developing electrochemical sensors for gases, liquids and solids for the past two decades. The higher sensitivity and simple construction of these sensors give them an advantage over other methods and make them ideal for trace detection.

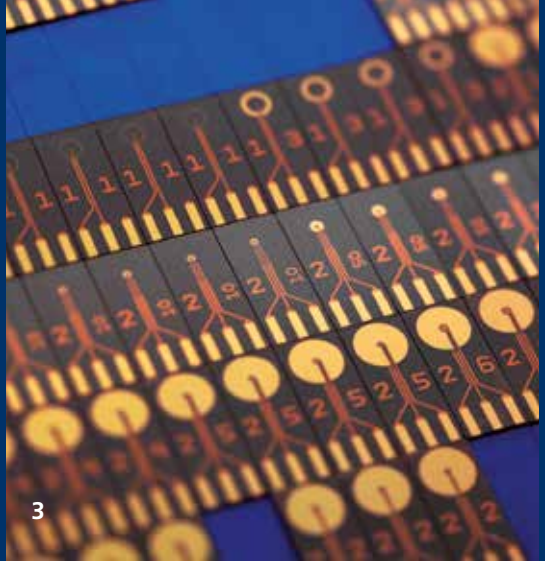
Trace detection in the gas phase

The measurement of very small concentrations is important for the detection of explosives in the gas phase, as the vapour pressure of these substances is very low and the concentrations decrease as distance from the source increases. For example, the vapour pressure of TNT (2,4,6 trinitrotoluene) at room temperature is only 7 ppb, and the vapour pressures of many other explosives are significantly smaller. Our measurement system can reproducibly generate explosives over a wide range of concentrations (ppm to ppt), in different gas flows and at different temperatures. With this calibration equipment the detection limits of the potentiodynamic sensor system were measured at 34 ppt.

Trace detection in liquids and soil

Current research is focused on sensors which can detect traces of hazardous substances in sea water. Together with our customers we develop, test and optimise sensors for manufacturing processes and safety/security technology, and develop concepts for new sensors.

A patented sensor has been developed for the investigation of TNT-contaminated soils at explosives factories and former military training areas. This sensor can rapidly and sensitively detect contamination.



COVER PHOTOGRAPH:

Testing and measurement equipment for sensor development

1 *Voltammogram of the explosive C4*

2 *Gas generation unit.*

3 *Microelectrodes.*

Pattern recognition using cyclic voltammetry

Pattern recognition based on cyclic voltammetry is a simple and rapid analytical tool for use in a wide range of applications, for example in the analysis of foodstuffs and mixtures, or in modular electronic noses. Further applications can be found in the environmental, mediacal and safety/security sectors.

Where conventional electrochemical sensors are used, individual substances are detected on the basis of characteristic properties such as oxidation and reduction reactions. However, the information provided by a cyclic voltammogram (CV) is more varied and can be used for pattern recognition. The additional, qualitative information obtained over the entire measurement range relates to diffusion effects, reaction mechanisms and reaction kinetics, and includes peak potentials, the position and displacement of peaks, and increases in the reaction flow.

Electrochemical investigation of apple juices, for example, demonstrated that the juices could be clearly differentiated solely on the basis of the electrochemical dara from CVs at gold electrodes. Different characteristics were extracted non-specifically from the individual CVs. The samples were then differentiated using pattern recognition, which identifies a specific pattern (fingerprint) for a specific formulation on the basis of a mathematical evaluation. Similar experiments were carried out with different sugars in solution. These could also be clearly differentiated. Further successful investigations were carried out with traces of explosives in both the liquid and the gas phase. The results demonstrate the wide-ranging possibilities and good applicability of cyclic voltammetry for pattern recognition.

Ionic liquids and CO sensors

The Fraunhofer ICT's Applied Electrochemistry Department has extensive konow-how in the selection and technical handling of ionic liquids for electrochemical applications. In the field of sensoric an electrochemical carbon monoxide sensor is currently being developed which can operate at temperatures of approximately 200°C.

Our offer

We offer the tailored development of pattern recognition methods and systems based on electrochemical methods for specific analytical applications.

On the basis of your specific measurement requirements we develop electrochemical methods and systems to detect low concentrations of substances in air, soils and water.

In particular we offer:

- characterisation of sensors
- investigation of electrolytes in electrochemical sensors
- gas mixing equipment for the testing and validation of sensors
- sample measurements using our measurement systems
- design and construction of measurement systems at our customers' sites
- characterisation, evaluation and calibration of existing measurement units
- literature research and market studies

We offer both comprehensive electrochemical laboratory facilities and a wide-ranging electrochemical know-how.

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