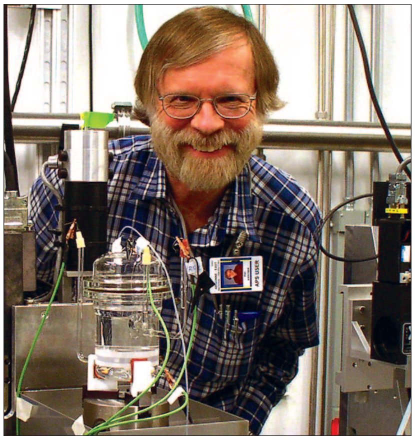

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Electrochemistry of interfacial structures

Our present research, which draws on the fields of analytical chemistry, physical chemistry, materials science, and biological sciences, is aimed at the study of interfacial structures using electrochemical techniques. One system under study is the interface between two immiscible solutions; while another is a solid surface of a metal, oxide, or ionic conductor immersed in a solution. The main research techniques used are voltammetry, electrochemical impedance spectroscopy, electrochemical noise analysis, mass change measurements using piezoelectric sensors, X-ray scattering, and optical probe beam deflection.

Electroanalytical chemistry; physical electrochemistry; electrochemistry of electrolyte interfaces; interfacial structure and transport; optical processes on electrified interfaces; sensors; electrochemical impedance; separations and microfluidics; fuel cells and hydrogen storage.

The interface between two immiscible solutions (e.g., water and nitrobenzene) containing dissolved electrolytes is the site of an electric potential similar to that found across biological membranes. This potential can be altered by changing the makeup of the solutions in contact; similarly, the makeup of the solutions can be altered by an applied electric current. The judicious choice of applied current or potential can be used to learn about the structure of the interface. Since the interface is very thin, it cannot be observed directly. Besides the electrochemical methods, indirect observations are made by studying the flux dispersion of a high-energy X-ray beam as it passes in proximity to the interface, using a synchrotron source.

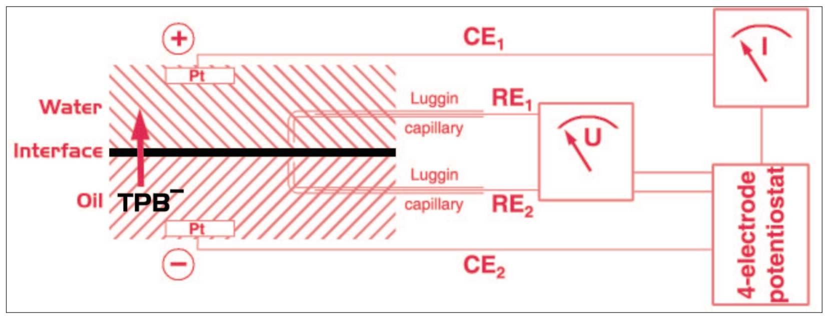

Diagram of the electrochemical cell used in the liquid-liquid interface experiments. A brochure describing his research is available directly from the author and on his personal Web page, www.vanysek.com/electrochem/.

The expertise gained on immiscible liquid interfaces can also be applied to studies of the interfaces between a solution and a metal. Many metals form layers of oxides on their surfaces. The nature of the oxides is very important in understanding corrosion, electrocatalysis in fuel cells and batteries, etc. These oxides are also increasingly important for the development of new technology associated with tiny supercapacitors.

Electroanalytical chemistry is also used as a detection tool in microfluidics separations. These involve separating an extremely small volume of a sample compound into its components, or analyzing it by a chemical reaction.

The range of practical applications of electrochemistry increases every year. Some of the pertinent areas are: electroanalytical chemistry; study of the structure of a double-layer; modeling of biochemical processes, especially in biological membrane models; elucidation of processes in ion sensitive electrodes with liquid membranes; study of processes involving electrochemical microdomains; metal surface analysis and corrosion studies; and development of new nanostructured materials.

Representative Publications

Luo, G.; Malkova, S.; Pingali, S. V.; Schultz, D. G.; Lin, B.; Meron, M.; Benjamin, I.; Vanýsek, P.; Schlossman, M. L. Structure of the interface between two polar liquids: Nitrobenzene and water. *J. Phys. Chem. B* **2006,** *110,* 4527–4530.

Vanýsek, P.; Delia, L. A. Impedance characterization of a quartz crystal microbalance. *Electroanalysis* **2006,** *18,* 371–377.

Luo, G.; Malkova, S.; Yoon, J.; Schultz, D. G.; Lin, B.; Meron, M.; Benjamin, I.; Vanýsek, P.; Schlossman, M. L. Ion distributions near a liquid–liquid interface. *Science* **2006,** *311,* 216–218.

Vanýsek, P. The glass pH electrode. *Electrochem. Soc. Interface* **2004,** *13,* 19-20.