Metrohm White Paper

Environmental analysis – An electrochemical contribution

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Electrochemistry plays a crucial role for all environment compartments, i.e., water, air and soil. In water, microbial fuel cells extract energy from wastewater, and Potentiostats monitor the associated electron transfer kinetics. In contaminated soils, Potentiostats track the redox reactions and the electrokinetic transport involved in electroremediation processes. Last but not least, Potentiostats track the electrochemical reactions that take place on catalyst surfaces – the place, where the greenhouse gas CO_2 is reduced to produce reactive carbon monoxide or methanol.

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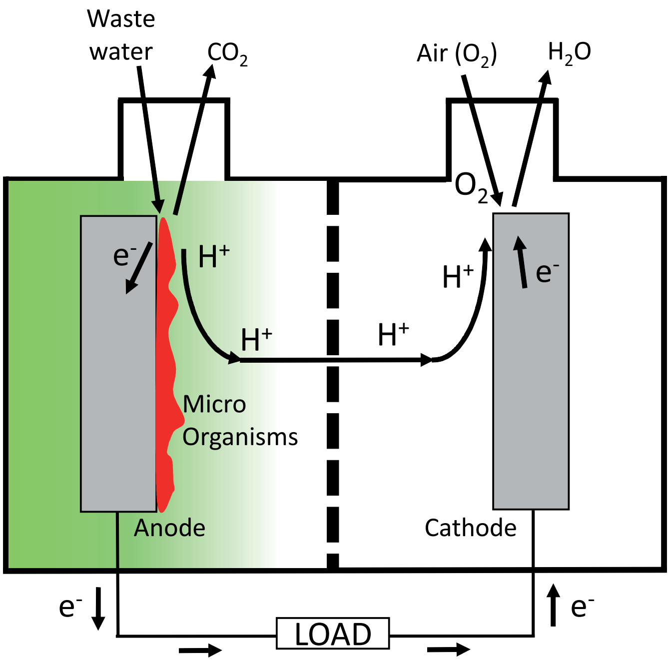
Water

Electrochemistry is of particular importance in characterizing microbial fuel cells, devices in which microorganisms convert oxygen and wastewater into clean water and electrical energy.

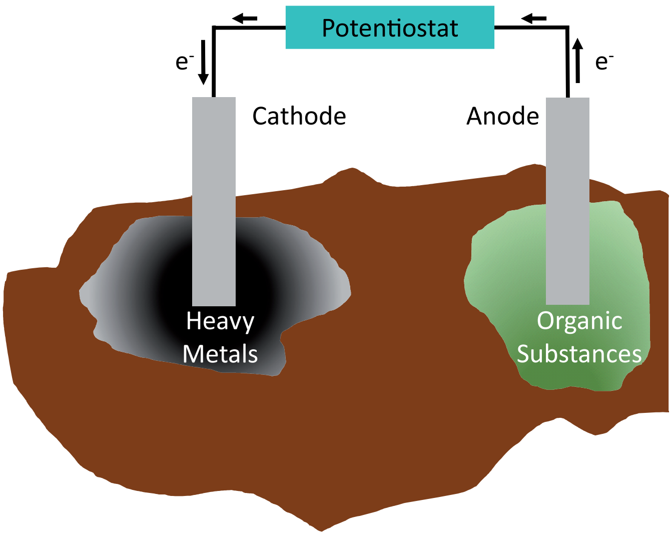


Here, the living process of microorganisms involve the breakage of complex organic molecules (the waste) into carbon dioxide (CO_2), protons H^+, and electrons e^-. The protons cross a proton-permeable membrane (represented as a dashed vertical line), while the electrons are collected in the anode and reach the cathode through a load. At the cathode surface, the recombination of protons and electrons, together with oxygen (O_2) from air, produces water.

In this respect, electrochemistry is an indispensable tool to provide information on the processes occurring in the microbial fuel cells [1–5]. Metrohm AUTOLAB provides complete electrochemical tools, such as the PGSTAT204 potentiostat with the FRA32M module.

Soil

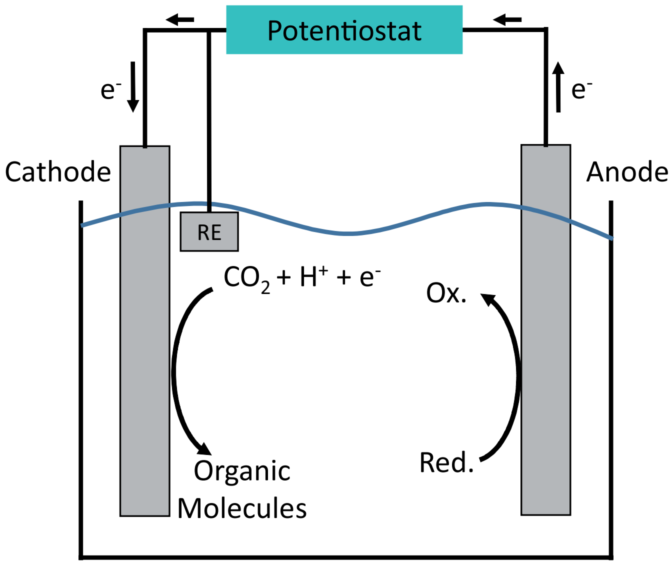
Electrochemical remediation is an in situ technique used to remove highly concentrated contaminants in soils. In a typical electrochemical remediation setup, the anode and cathode are inserted in the soil and direct current is passed through. Soil contaminants migrate at the electrodes, resulting in reduction of heavy metals ions at the cathode and oxidation of organics substances at the anode [7, 8]. The electrochemical remediation has been the first field of electrochemistry where AUTOLAB potentiostats/galvanostats have been developed. The PGSTAT302N, together with the BOOSTER20A form the best setup to perform in situ electrochemical remediation. Cyclic voltammetry, together with galvanostatic techniques, are used to monitor the redox reactions occurring in the soil under treatment.



Air

One of the main pollutants affecting the atmosphere is the greenhouse gas carbon dioxide (CO_2). This molecule is the main responsible for global warming, which is severely changing the climate conditions worldwide through the greenhouse effect.

Therefore, there is a need to decrease CO_2, and the electrochemical reduction of carbon dioxide looks promising, since CO_2 is used as source for producing fuels and small organic molecules. Cyclic voltammetry or chronoamperometry are the main electrochemical techniques in use. The cathode of an electrochemical cell hosts a catalyst, which speeds up the reduction of CO_2. For example, copper has been found being a good catalyst for reducing CO_2 dissolved in aqueous solution. In addition, other metals have been used as catalysts, as well as carbon materials [6].



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WP-004EN, published January, 2015

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