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Ion-selective electrodes and ion-sensors – engineering analytical tools

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The ion-selective electrode is an electrochemical sensor that allows specific determination of ions in a biological, environmental, ori ndustrial origin matrix. Measurement of pH and ions such assodium, potassium, chloride, bicarbonate, ammonia, calcium, magnesium, fluoride, nitrate, silver, cadmium, and leadarenowavailable. The lecture will showthe essential material and physicochemicalprinciples, milestones, and challenges in electrochemical ion sensing.

Each ion-selective electrode is based on a process of ion-to-electron coupling, i.e., the ion to be determined and electron to serve amplified for information on ion quantity. The ions are sensed by a membrane, a crucial part of the electrode. The membranes contain activesites inducing sensitivity to preferred ions, and they are made from glass, crystals, or plastics. Partition of the ions between the sample and membrane is responsible for signal formation. Nernst-type equations describe the signal taken in an open circuit (zero-current) under equilibrium. Nernst-Planck-Poisson equations extended the signal theory, which can be applied for non-zero current signals, as well as time and space domains. Non-equilibrium signals and responses over a short time are thus engaged in a routine fast sample through put analysis.

The internal contact is conventionally made by the internal solution containing the preferred ions, chlorides, and silver chloride electrode. To integrate the ion-selective electrodes, the internal solution was eliminated and substituted by a so-called solid contact. Conducting polymers were first proposed as the suitable material, and a new class of ion-selective electrodes, called ion-sensors, was established. Now a plethora of different contacts made of nanocarbon, metal structures, or functionalized composites is offered. Consequently, the ion-sensors can be miniaturized, positioned in the multi electrode platforms, 3D-printed, sterilized, and made ready for use.

The ion-sensors today are reliable, robust, and price-attractive tools for many analytical applications. Clinical measurements in blood, drinking water, process liquids, and waste water control are most attractive applications.