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1 *Screen-printed potentiometric sensors*

THIN-FILM ELECTRONICS ELECTROLYTE SENSORS

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Thin-film electronics

Large-area thin-film devices and sensors are leveraging distributed sensing applications in wearable electronics and beyond. Unique features like ultrathin system design, mechanical flexibility, and simple assembly allow for facile and subtle integration into textiles at consumer-acceptable pricing.

System development

IISB expertise in thin-film materials and devices is translated into specialty sensors. From the sensor characteristics, application scenarios are derived in close collaboration with our partners. Customized read-out and data handling circuitry is realized either yielding fully integrated thin-film or hybrid systems. The latter utilize conventional silicon microelectronics, e.g. discretes, ICs, or microcontrollers.

What is my fitness status?

Novel sensors for electrolytes and metabolites in sweat allow in depth monitoring of health and fitness parameters.

Vital parameters from sweat electrolytes

Smart sensors in sports textiles offer an unobtrusive method of continually monitoring physiological parameters during exercise. The electrolyte sensor targets the monitoring of ammonia levels in sweat. Real time analysis without need for hindering or even invasive sample collection is a clear advantage over blood analysis.

Ammonia and ammonium in blood are mostly a result of metabolic degradation of proteins during muscular overstrain. Ammonia molecules are permeable through cell membrane and further on get easily transported from blood to sweat. During physical strain the content of ammonia in sweat is in the range of millimols, which is orders of magnitude higher than in normal condition.

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System integration

The electrolyte sensor combines perfectly with complementary data from breast belt (cardio-vascular), motion sensors, and GPS (local tracking) to give reliable information on the fitness status. Identification of ideal workout conditions, optimization of training quality, and prevention of overstress can thus be realized by a single electronic appliance. The biochemical sensor system, realized as a fully screen-printed biocompatible solution, employs planar integrated solid-state electrodes. A major challenge is the formulation of the electrode surface to allow reproducible measurements and sustained functionality. Established materials systems like inert carbon or degradation-resistant Ag/AgCl for the electrodes are combined with newly developed and affordable NH_4^+ -selective membranes. For integration into wearables, electronics were developed by our partner Fraunhofer IIS as a small hand-hold, standalone device. The data are transfered via Bluetooth (BLE) and are evaluated by a specifically developed Android application.

Evaluation

In a potentiometric measurement scheme the electromotive force EMF is extracted. The EMF is forming across the membrane when both reference and working electrodes are in contact with the solution.

In line with the Nernst equation, the EMF is proportional to the logarithm of the ammonium activity. Fig. 4 shows the voltage response upon modification of activity of the ammonium by exchanging standard solutions of concentrations.

Meeting your demands

The fastly and cheaply fabricated ion-selective screen-printed sensors show a high potential for analysis of physiological electrolytes in sweat. Moreover, the sensitivity can be modified to a broad range of ionic analytes opening new possibilities for biochemistry, industrial- and consumer-level diagnostics (e.g. food, pharmaceuticals), security, and home appliances. Approach Fraunhofer IISB for a customized solution to your analytical problem.

2 *Screen-printed potentiometric sensor during characterization*

3 *Sensor with FitnessShirt*

LZE Leistungszentrum Elektroniksysteme

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4 *The EMF response to the concentration change of ammonium ions shows a high dynamic range making the electrolyte sensor well suited for challenging analytical tasks*