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Switchable trace oxygen optode – combining the principle of the STOX electrode with optical oxygen sensors

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Accurate and precise measurement of dissolved oxygen is a key issue in aquatic science since the oxygen partial pressure is an important factor for all organisms. The distribution of oxygen in aquatic systems can also be used to assess microbial activity.
To date, two types of sensor techniques are available for oxygen measurement: electro¬chemical sensors (electrodes) and optical sensors (optodes). The latter ones have found wide applications during the last years due to their robustness and long term stability, on the one hand. On the other hand, the recently introduced switchable trace oxygen electrode ("STOX electrode") enables detection of very low levels of oxygen. However, these electrode based sensors are extremely fragile and expensive and require sophisticated electronics for readout. We present a combination of the STOX principle with bulk optode technology. To achieve this, a very thin (e.g. 100 nm) nanoporous gold layer is deposited on top of the luminescent sensing layer of the optode. Upon electrical polarization, oxygen is reduced and hence depleted within the gold layer; a zero reading can thus be established. This new approach allows combining the robustness and accuracy of the optode concept with high precision measurement capabilities of the STOX technique at (ultra) low oxygen concentrations. Additionally, a 1-point calibration of optodes for long term applications is facilitated.