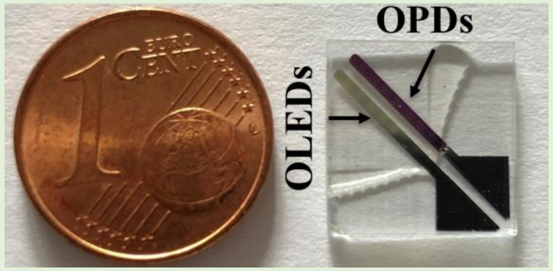
SOILMONITOR

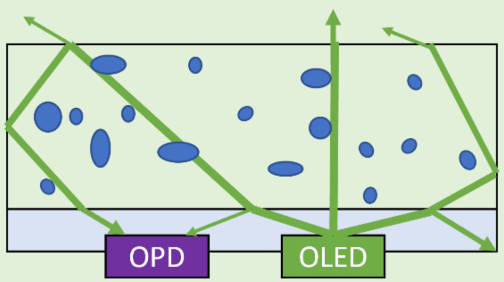
Optoelectronics



The sensor unit itself is smaller than a cent. It consists of organic LEDs (OLEDs) and organic photodetectors (OPDs), in this case eight each, and is located under the reaction chamber. Each OLED or OPD unit measures just 0.5 mm x 0.5 mm.

Photometry

Photometry determines concentrations of substance quantities via extinction (attenuation of the photo signal). A light source (green) indirectly irradiates a photodetector (purple), whereby the dye formed by a chemical reaction absorbs and scatters part of the light. This leads to a decrease in the photocurrent measured at the photodetector, allowing the concentration of a substance to be determined.



Contact

Prof. Dr. Martina Gerken

Integrated Systems & Photonics
Tel.: +49 431 880 6250
Mail: mge@tf.uni-kiel.de

CAU
Kiel University
Christian-Albrechts-Universität zu Kiel

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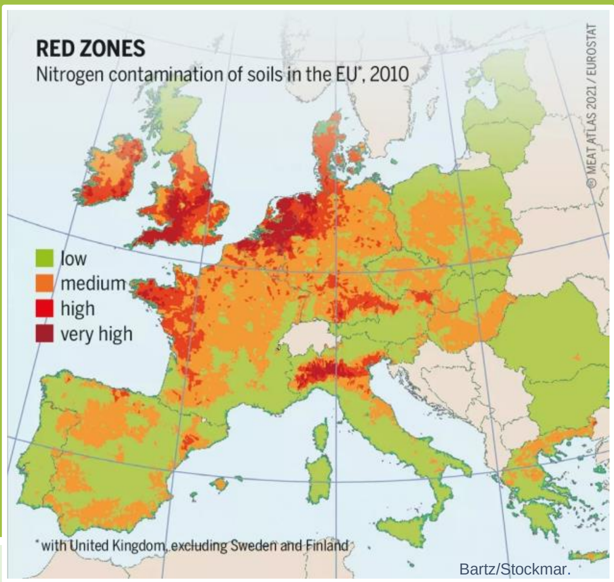
Der SOILMONITOR

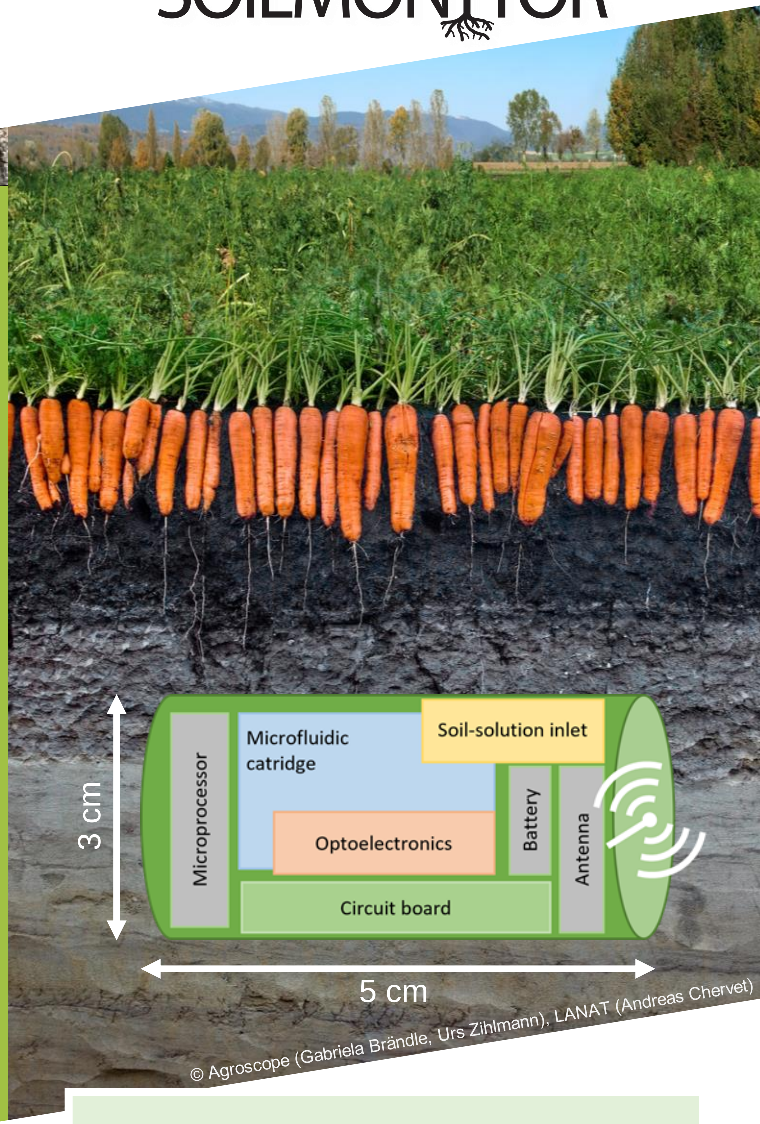
Background

The pressure on agricultural production is growing worldwide. In order to compensate for limiting factors such as population growth, global warming, rising costs for mineral fertilisers, conflicts and the decline in productive soils, cultivation conditions must be optimised more and more. To this end, the SOILMONITOR project is developing a nutrient sensor for nitrate, ammonium and phosphate. The special features here are automation, rapid measurement and the possibility of creating a time series. This will enable farmers to make better decisions, for example on fertilisation.



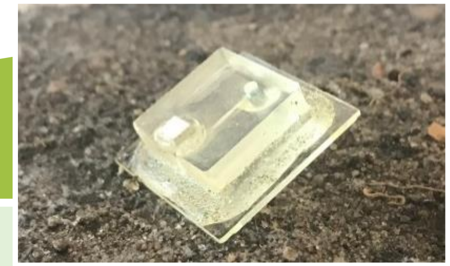
Nitrate-contaminated soils in the EU, 2010.

These analyses are also important in the context of environmental pollution: nitrogen over-fertilisation is a global problem, and soil acidification, eutrophication, biodiversity decline and water pollution are the consequences.

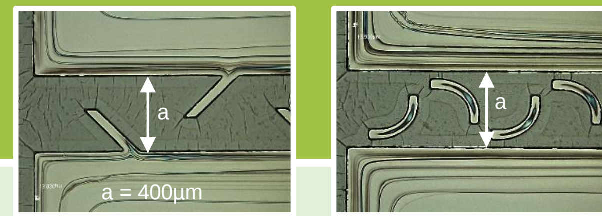


Schematic structure of the sensor consisting of three compartments: Power supply (batteries); microfluidics (inlet, microfluidic chip, OLED/OPD) & control (circuit board, processor). The sensor unit stays buried for up to a year. Soil solution is drawn in via the inlet, mixed with the assay and measured in the reaction chamber.

Microfluidics



Soil solution extraction is performed using a unit consisting of a ceramic inlet (white), microfluidic channel and outlet. In the finished sensor, the unit is integrated into the microfluidic chip. A pump draws the soil water through the ceramic into the microfluidics for analysis.



Mixer structures under the confocal microscope.

The nutrient analysis on the chip is carried out by photometry (see reverse). A chemical assay reacts with the nutrient and forms a dye. However, for this reaction to take place, the soil water and reagent must first be mixed. Shown below is a test chip with outlet, reaction chamber (here without sensor unit), serpentine mixer, Y-junction and inlets (from left to right).