Technology Offer

Efficient Optical Readout: Highly Versatile Chemical Sensor

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The invention relates to an innovative detector concept for the identification of analytes in a gas that is extremely versatile and yet easy to construct and to operate. The superior properties were reached by an optical readout system for electrical signal of multiple detector cells.

Detecting and quantifying concentrations of analytes of interest is usually achieved using materials that change their electrical properties upon exposure. As different materials combined in one sensor need different readout circuits, state-of-the-art sensors need highly complex wiring and are hence difficult to scale.

The newly developed detector converts varying electrical characteristics into an optical signal for each sensing element individually. This makes a common readout significantly easier and allows high-performance sensors to be built in a compact way using a simple architecture.

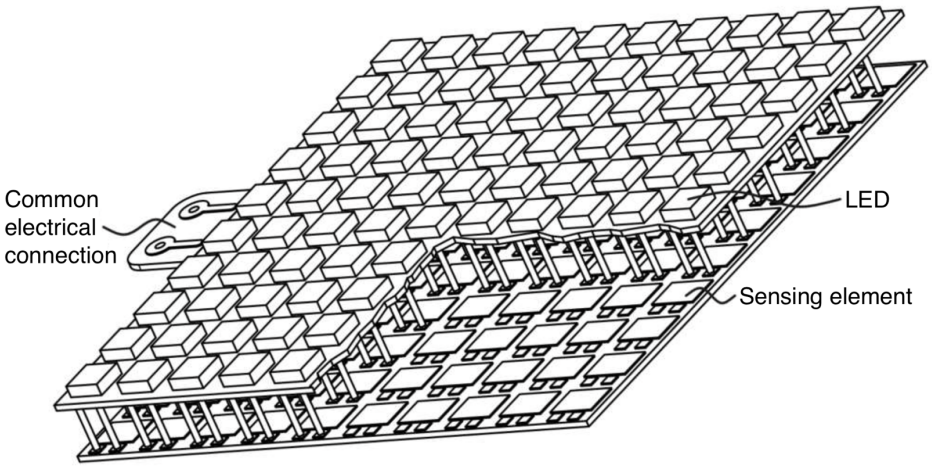

Fig. 1: A large sensor with various chemical pixels sensitive to different analytes can be constructed using the novel method. Changing electrical properties of the sensing elements change the LED output. The latter can easily be monitored for all pixels by a photodetector. A common electrical connection serves as a power supply for the LEDs.

Advantages

- Simple design
- Large and versatile detectors possible
- No complex wiring for multiple sensing elements
- Compact architecture with sensing elements directly located on an LED
- Scalable to different sizes and numbers of sensing elements
- Adaptable for aqueous analytes

Applications

- Detection of chemical compositions
- Detection of air pollution or toxic trace gases
- Quality assurance

Max-Planck-Innovation GmbH
Amalienstr. 33
80799 München
www.max-planck-innovation.de

Background

Detailed analysis of analytes in gaseous samples is of great interest both for scientific but also civil applications. State-of-the-art sensors are based on changing electrical properties, e.g., the resistance, of different materials when they are in contact with investigated chemicals. However, it is difficult to construct larger sensors with multiple different sensing elements as each of them requires an individual readout circuit hence drastically increasing the sensor's complexity. Approaches to observe changing optical properties within the sensing elements have been regarded in the past but are problematic as they typically use up the detector material, hence having a strongly reduced lifetime.

Technology

A novel sensor concept has been developed to overcome the aforementioned shortcoming combining the advantageous of both an electrical and optical readout system.
Different sensing materials cause different electrical signals that must be monitored for multiple pixels when exposed to a mixture of analytes. By using the individual electrical signals of each sensing element as an input to an individual optical device, e.g., an LED, they are converted into optical signals. It is thereby much easier to detect optical signals from a large array of chemical pixels, as a single imaging device can acquire data simultaneously from all sensing elements. LEDs are thus highly advantageous as they can be directly implemented into a small-scale sensing element.
Figures 2 a) and b) visualize the simple layout of a chemical sensor as a possible implementation according to the invention. Sensing elements are connected to the common voltage supply and via the LED to the common grounding. A transparent substrate allows for the optical signals to be transmitted to a common imaging device (not shown).
An optical image of the sensor contains the response of the entire sensor array to the exposure with chemical analytes. This image can be evaluated using computational methods like machine learning.

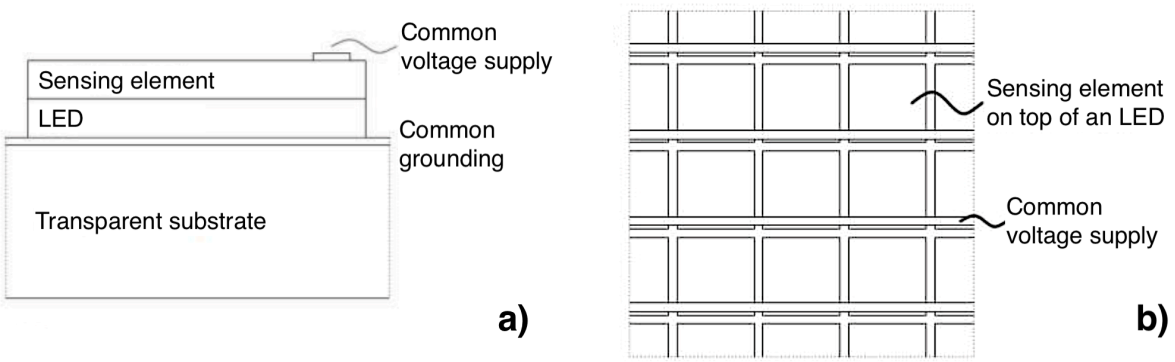

Fig. 2: a) The cross section of a sensor according to the invention reveals the uncomplicated architecture. Sensing element and optical emitter (i.e., LED) are physically and electrically connected. **b)** A front view of a sensor according to the invention shows its large active area and the voltage supply on top.

Patent Information

PCT *(Application filed)*

Contact

Dr. Bernd Ctortecka
Senior Patent- & License Manager
Physicist
Phone: +49 (0)89 / 29 09 19 - 20
eMail: ctortecka@max-planck-innovation.de

Max-Planck-Innovation GmbH
Amalienstr. 33
80799 München
www.max-planck-innovation.de