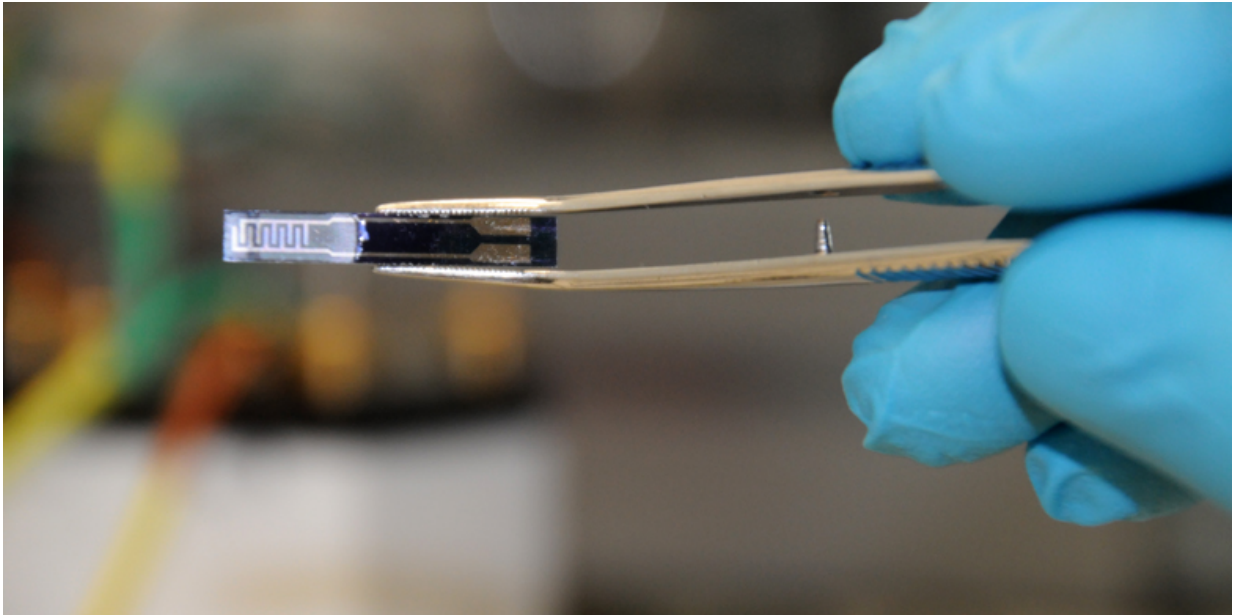


New composite material as CO₂ sensor

June 8 2015, by Fabio Bergamin



ETH researchers' miniature CO₂ sensor is pictured: chip with a thin layer of the polymer-nanoparticle composite. Credit: Fabio Bergamin / ETH Zurich

A new material changes its conductivity depending on the concentration of CO₂ in the environment. The researchers who developed it have utilized the material to produce a miniature, simply constructed sensor.

Material scientists at ETH Zurich and the Max Planck Institute of Colloids and Interfaces in Potsdam have developed a new type of sensor that can measure [carbon dioxide](#) (CO₂). Compared with existing sensors, it is much smaller, has a simpler construction, requires considerably less

energy and has an entirely different functional principle. The new sensor consists of a recently developed [composite material](#) that interacts with CO₂ molecules and changes its conductivity depending on the concentration of CO₂ in the environment. ETH scientists have created a [sensor chip](#) with this material that enables them to determine CO₂ concentration with a simple measurement of electrical resistance.

The basis of the composite material is a chain-like macromolecule (polymer) made up of salts called [ionic liquids](#), which are liquid and conductive at room temperature. The name of the polymers is slightly misleading as they are called "poly(ionic liquid)s" (PIL), although they are solid rather than liquid.

Unexpected properties

Scientists worldwide are currently investigating these PIL for use in different applications, such as batteries and CO₂ storage. From their work it is known that PIL can adsorb CO₂. "We asked ourselves if we could exploit this property to obtain information on the concentration of CO₂ in the air and thereby develop a new type of gas sensor," says Christoph Willa, doctoral student at the Laboratory for Multifunctional Materials.

Willa and Dorota Koziej, a team leader in the laboratory, eventually succeeded by mixing the polymers with specific inorganic nanoparticles that also interact with CO₂. By experimenting with these materials, the scientists were able to produce the composite. "Separately, neither the polymer nor the nanoparticles conduct electricity," says Willa. "But when we combined them in a certain ratio, their conductivity increased rapidly."

Chemical changes in the material

It was not only this that astonished the scientists. They were also surprised that the conductivity of the composite material at room temperature is CO₂-dependent. "Until now, chemoresistive materials have displayed these properties only at a temperature of several hundred degrees Celsius," explains Koziej. Thus, existing CO₂ sensors made from chemoresistive materials had to be heated to a high operating temperature. With the new composite material, this is not necessary, which facilitates its application significantly.

Exactly how the CO₂-dependant changes in conductivity were produced is not yet clear; however, the scientists have found indications that a chemical change induced by the presence of CO₂ occurs foremost at the interface between the nanoparticles and the polymers at the nanometre scale. "We think that CO₂ effects the mobility of the charged particles in the material," says Koziej.

Breathing gauges for scuba divers

With the new sensor, scientists are able to measure CO₂ concentration over a wide range - from a concentration of 0.04 volume percent in the earth's atmosphere to 0.25 volume percent.

Existing devices that can detect CO₂ measure the optical signal and capitalise on the fact that CO₂ absorbs infrared light. In comparison, researchers believe that with the new material much smaller, portable devices can be developed that will require less energy. According to Koziej, "portable devices to measure breathing air for scuba diving, extreme altitude mountaineering or medical applications are now conceivable".

More information: Willa C, Yuan J, Niederberger M, Koziej D: When Nanoparticles Meet Poly(Ionic Liquid)s: Chemoresistive CO₂ Sensing at Room Temperature. *Advanced Functional Materials* 2015, 25:

2537-2542, [DOI: 10.1002/adfm.201500314](https://doi.org/10.1002/adfm.201500314)

Provided by ETH Zurich

Citation: New composite material as CO₂ sensor (2015, June 8) retrieved 8 April 2024 from <https://phys.org/news/2015-06-composite-material-co2-sensor.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.