New Non-invasive Formaldehyde Sensor Can Detect Adulterated Fish at Room Temperature

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A new low-cost sensor made of metal oxide nanoparticlesreduced graphene oxide composite can detect formalin adulteration in fishes at room temperature in a non-invasive way. The sensor shows long-term stability with a low detection limit.

Food adulteration is the practice of adding illegal or harmful substances to food to make it appear more appealing or to increase its shelf life. Formaldehyde is a colourless, pungent gas that is used in a variety of industrial processes, including as a preservative in some foods, commonly in fish in developing countries. However, the use of formaldehyde in food is illegal in many countries, as it is a known carcinogen.

Commercial formalin sensors for fish are primarily electrochemical-based or colorimetric-based. Electrochemical sensors are extensively used but are expensive. On the other hand, calorimetric sensors are less expensive. But both methods are invasive in nature. Moreover, low-level detection and selective detection are two major issues with these sensors. The development of 2D materials-based gas sensors has created a new avenue of effective detection of toxic vapors at room temperature. These sensors have the potential to detect the formalin evaporated from adulterated food products.

Image showing the set-up for formalin detection in adulterated fish at the laboratory using Keithley sourcemeter by tin oxide- rGO sensor.

Nanomaterials and Nanoelectronics Laboratory, headed by Dr. Hemen Kr. Kalita, Assistant Professor, Department of Physics, Guwahati University, Assam has developed a cost-effective

formalin sensor using tin oxide-reduced graphene oxide composite that can effectively detect the presence of formalin in adulterated fishes.

Graphene oxide (GO), the oxidized form of graphene, exhibits high solution processability and ease of chemical modification with other materials such as metals, metal oxides, or polymers. However, the low electrical conductivity of GO posed a challenge and the scientists overcome this by developing the tin oxide-reduced graphene oxide composite (rGO- SnO2).

While reduced graphene oxide (rGO) has been used to detect various toxic gases and VOCs, tin oxide (SnO2) has been extensively investigated for formaldehyde detection in pristine form and by incorporating it with various compounds, including graphene, due to its high stability and high sensitivity toward low concentrations of formaldehyde.

The researchers synthesized graphene oxide (GO) through process called wet chemical approach and tin oxide-reduced graphene oxide composite (rGO- SnO2) was synthesized by hydrothermal route followed by calcination of the obtained product. They found that the sensor made of tin oxide decorated reduced graphene oxide effectively sensed formaldehyde vapor at room temperature.

The sensor has been tested for adulterated fish at lab scale as well on fish available in the fish markets of the Guwahati region. The research for this supported by DST-PURSE (Promotion of University Research and Scientific Excellence) was published in the journal ACS Appl. Nano Mater. It was observed that the sensor could detect the presence of formalin in many fish sample units that are imported from regions outside the state of Assam. The crucial importance of this work is the non-invasive detection of formalin.

The designing of the prototype is in process in the lab which may be regarded as a breakthrough in the field of food adulteration. The prototype of this sensor will open new avenues for the development of affordable formalin sensor devices.

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