Tautomeric Sensing with a Covalent Organic Framework (#8262)

Useful for gas- and liquid-phase sensing

This crystalline, porous polymer system reversibly changes color in the presence of volatile compounds. Facilitated by the chemical phenomena known as tautomerization, the color change is highly responsive and fast, occurring within seconds. This Georgia Tech innovation enables the development of passive and reversible sensors useful for a host of gas- and liquid-phase sensing.

The polymer's porosity and structural regularity combine with the rapid exchange rate and reversibility associated with tautomerism to produce a solid-state covalent organic framework (COF). In laboratory demonstrations, a colorimetric humidity sensing device constructed from an oriented thin film of the COF responded quickly to water vapor and was stable for months. These results suggest that tautomerization-induced electronic structure changes can be exploited in COF platforms to provide rapid, reversible sensing in systems that exhibit long-term stability.

Benefits/Advantages

- **Fast**: Provides highly responsive color change within seconds
- **Passively reversible**: Does not require external stimuli for regeneration
- **Long-term stability**: Sensing ability extends for months
- **Scalable**: Easily fabricated on a large scale

Potential Commercial Applications

This material, along with its underlying mechanism, is ideal for a wide variety of gas- and liquid-phase sensing:

- On-board sensors in electronic devices
- Passive sensors in Internet of Things (IoT) systems
- Matrix sensors for biological, water remediation, and air-quality uses

Background/Context for This Invention

Tautomers are constitutional isomers that are interconverted by migration of an atom or group of atoms—most commonly a proton—from one site to another. This chemical change is often rapid, and the relative stability of the tautomers can depend strongly on the surrounding environment, including the presence or absence of volatile species. Because tautomers often display rapid interconversion, sensitivity to different chemical stimuli, and switchable optical behavior, engineers have found extensive uses for them as molecular probes.

COFs are permanently porous and structurally precise polymer networks, and their chemical versatility and porosity make them an attractive platform for the detection of volatile analytes.

Georgia Tech’s approach enhances the magnitude of the optical shift in a COF structure by incorporating tautomerically active subunits. In contrast with solvatochromism, which relies on stabilization of a single chromophore, tautomerism allows for a new chromophore to be generated upon exposure to volatile analytes. This innovation demonstrates the viability of practical tautomeric sensing and its use in engineered devices capable of complex sensing responses for volatile analytes in these materials.

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More Information

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Publications

Humidity Sensing Through Tautomerism of a Covalent Organic Framework, Journal of the American Chemical Society, January 2, 2020

For more information about this technology, please visit:
https://licensing.research.gatech.edu/technology/tautomeric-sensing-covalent-organic-framework

Images:

The automated sequential delivery of multiple fluids. A varying number of delay gates imprinted in the branches are shown in the figure.

COVID-19 and flu saliva test on paper: (A) The automatic sequential delivery of multiple reagents required for virus test; (B) Water pouring into the device triggers the virus assay, allowing the presence of SARS-CoV-2 and influenza A & B viruses to be visually identified by the color changes in the corresponding detection spot