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Color-Changing Array Identifies Odors

CHAMPAIGN, Ill. -- For years scientists have been attempting to emulate a pretty good chemical detector: the human nose. Now an array of chemical sensors may provide a straightforward process for identifying smells that is far more sensitive.

The array consists of metalloporphyrins deposited on a silica gel. The metalloporphyrins are produced by attaching a metal atom, such as tin, cobalt or iron, to a tetraphenylporphyrinate molecule. The different molecules respond differently to the presence of chemical analytes.

A chemical array developed at the University of Illinois sees smells. Odor molecules create different patterns on the array. The array detects the smell of overripe fruit, left, and rum.

Specifically, the metalloporphyrins change color in a phenomenon that the researchers call "smell-seeing." "Smell-seeing is just so simple and elegant," said Kenneth S. Suslick, a professor of chemistry and leader of the research team at the University of Illinois. "The same approach could have been done 50 years ago with film and filters, but no one ever thought of it."

To generate the color patterns, the researchers inserted the array into

a stainless steel cell with a mixture of chemicals and nitrogen gas. They recorded the color patterns that emerged with an ordinary flatbed scanner and, using Adobe PhotoShop software, stretched the color scales and subtracted the baseline image from the images in the presence of various chemical compounds.

Suslick and graduate student Neal Rakow found that each chemical creates a unique color signature. They also found that, because the metalloporphyrins do not display hysteresis effects, subsequent exposures do not compromise the repeatability of using the technique with an array. "The aroma molecules bind to the metal centers, but the binding is reversible, and they will come off the surface in a minute or so," said Suslick.

Moreover, he noted that, while other processes under development to sense smells are typically sensitive to humidity, the smell-seeing process is not. And it is 10 to 100 times more sensitive than the human nose for some compounds.

The smell of success

In the first arrays, the metalloporphyrins reacted in about 30 seconds because they covered a large surface area. A smaller version, with 500-µm metalloporphyrin spots on a Teflon substrate, demonstrated much faster color saturation. Suslick will continue to miniaturize the detector array and hopes to match it with a CCD. With dedicated custom software, he expects to produce an odor sensor the size of a Sacajawea dollar.

Suslick said that dosimeter badges made with the technology may be useful for monitoring toxin exposure in the workplace or serving as early warning systems against poisonous gas. Other applications may include detecting spoiled food or performing medical diagnoses by the "smell" of bacteria. Another possible application, said Suslick: "Burnt popcorn prevention for all of our microwaves!" □

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