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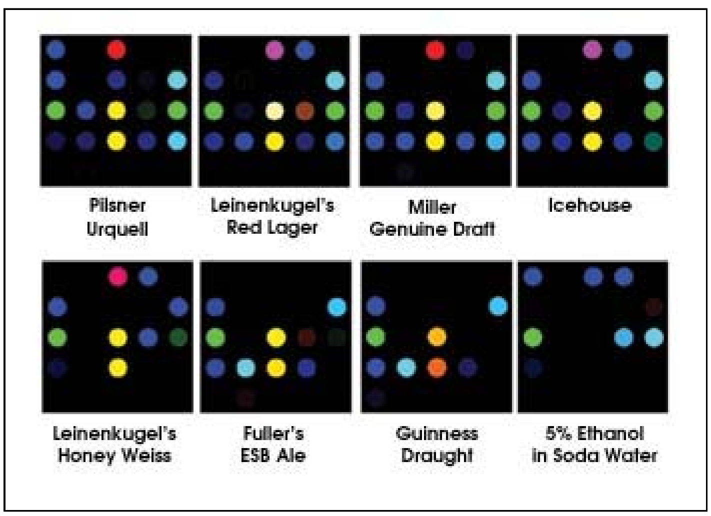
Using photonics to solve problems of the real world

Testing (and Tasting) Beer on Sight

by Hank Hogan, Contributing Editor

Kenneth S. Suslick was not under the influence, even though he was discussing an optical beer-testing technique that essentially tastes and smells a substance visually. Suslick, the Marvin T. Schmidt professor of chemistry at the University of Illinois at Urbana-Champaign, soberly noted that the new method successfully distinguishes various beers, detects dilution resulting from added water, and spots degassed, or flat, beer.



The distinct tastes and smells of various beers show up visually in these colorimetric arrays, which are composed of dyes that change color when exposed to chemistries. The plots show the difference between the dot color before and after exposure to various beers and a control. Images courtesy of Kenneth S. Suslick.

"This technology might be termed an 'optoelectronic nose' or an 'optoelectronic tongue,' depending on whether it is sensing gases or liquids," Suslick explained. "In the study on beers, we actually did both and even combined the data, much as any person does in smelling and then tasting."

Colorimetric arrays are the basis of the chemical sensor devised by Suslick and his colleagues. They are fabricated using chemically responsive dyes that undergo a color change as a result of one of several possible intermolecular interactions. Unlike other techniques, colorimetric arrays are inexpensive, one-time-use devices, so no calibration is needed, and reversibility is not an issue. The arrays also differ in that they use a full gamut of binding interactions instead of relying solely on the weakest of all, adsorption.

This colorimetric array, shown here mounted in a cartridge, is a small, disposable chemical sensor with an optical readout. Researchers measure the array response using an inexpensive flatbed scanner.

Suslick, who founded the company ChemSensing Inc. in Champaign, has worked on developing colorimetric arrays for several years. The company's emphasis is on early-stage disease detection, but Suslick has applied the technology to other subjects, including volatile organic compounds and, now, beer. People can smell and taste the difference between beers, and Suslick noted that the colorimetric approach has some advantages when it comes to duplicating that feat.

"Because we probe a very wide range of intermolecular interactions — and not just physical adsorption, as with most prior technology — our data has a much, much higher dimensionality and, hence, a much greater ability to differentiate among very similar analytes," he said.

In a study reported in the July 12 issue of the *Journal of Agricultural and Food Chemistry*, Suslick and his team used an array of 36 dyes for gas-phase analysis — the equivalent of smell — and 25 dyes for liquid-phase analysis, analog of taste. They fabricated the array of dots by transferring the dye via stainless steel pins from an ink-well array to a hydrophobic membrane. Using a $100 flatbed scanner from Epson America Inc. of Long Beach, Calif., they measured the red, green and blue values of each dot before it was exposed to the gas or liquid from 18 beer samples. They made the same measurements after exposure and calculated the difference in values for each of the three colors for every 10-pixel-radius spot.

They analyzed the resulting 8-bit values as points in a multidimensional space, then determined which characteristics best defined the various beers using hierarchical clustering analysis, a technique that transforms the multidimensional distance between points into a treelike figure that makes it easy to visualize similarities. They found that they could classify the beers into the appropriate categories with a 2.7 percent error rate. Moreover, their analysis differentiated between beer and lager, between beer and ethanol controls, and among flat, watered-down and unadulterated beers.

Suslick noted that their results demonstrate that the technique could be used for quality assurance and control of beer. However, he added that it also could be used in a wide variety of applications for quantitative assessment of anything that has a smell or a taste.

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