news of the week
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Sensor array aims to mimic human tongue

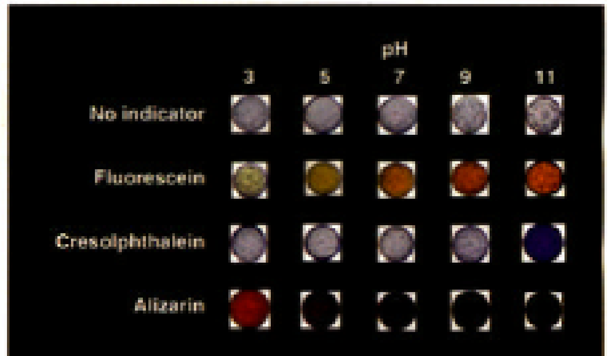
The human sense of taste can identify sweet, sour, salty, and bitter substances but it usually can't relay information on the exact chemical composition of these substances. Such chemical identification, though, is a goal of scientists around the world who are trying to develop artificial taste sensors that mimic the human tongue. The latest report in this field comes from a research team in Texas that has devised a sensor array that can simultaneously detect several chemical species in solution - an early step in the development of (an "electron-ic tongue" [J. Am. Chem. Soc. 120, 6/29 (1998)].

Another sensory mimic - the electronic nose, being developed in several other labs - can detect volatile molecules in the air. But since many chemicals of interest, such as those in food and beverages, are not easily transported into the vapor phase, there needs to be a way of detecting combinations of them in solution, says John T. McDevitt, associate professor of chemistry at the University of Texas, Austin. To tackle this problem, McDevitt joined forces with two other chemists on the faculty- Eric V. Anslyn and Jason B. Shear - and with electrical engineering professor Dean Neikirk.

The primitive electronic tongue they and their coworkers are developing resembles the mammalian tongue in some ways. The surface of the human tongue contains cavities that hold chemical receptors known as taste buds. The artificial tongue created by the Austin re-searchers is a silicon-silicon nitride water that contains micromachined wells. Into each well is placed an artificial taste bud - a polymer bead that is derivatized with receptor sites for the analyte of interest as well as indicator molecules that undergo distinctive color or fluorescence changes when specific analytes bind to the receptors.

These color changes can he detected by shining white light into the wells and collecting the light as it exits through the well's transparent bottom. The light is collected by a charge-coupled device (CCD) - basically a video camera that measures the absorbance of red, green, and blue wavelengths.

To demonstrate the concept the Austin team prepared a simple sensor array consisting of four different kinds of responsive beads. These beads were derivatized with either fluorescein (a dye that responds to pH), o-cresolphthalein complexone (for detecting Ca^{2+} and pH), alizarin complexone (for Ca^{3+}, Ca^{2+}, and pH), or a boronic ester of a galactose derivative (for simple sugars). Alizarin complexone, for example displays different colors (yellow to deep purple) depending on the pH and the concentrations of Ca^{3+} and Ca^{2+}.



The taste buds of an "electronic tongue" consist of poly(ethylene glycol-styrene) beads derivatized with an indicator dye molecule. A color change signals the binding of an analyte to the bead's receptor sites. The three derivatized beads in each column are shown responding to aqueous solutions of Ca^{2+} having different pH values.

The sensor array is placed inside a thin capillary cell and the solution to be analyzed is allowed to flow over it. The polymer beads inside their wells respond to the analytes in less than a minute.

When developed further, the electronic tongue should be able to analyze food products, beverages, chemical processing streams, biomedical fluids, and other complex mixtures without exposing human beings to possibly harmful substances, McDevitt says. The researchers are working on chemically more sophisticated sensor arrays for detecting antigens, toxins, and bacteria.

MeDevitt points out that "a particularly powerful attribute" of the electronic tongue is that different mixtures can he compared to a standard without any knowledge of the chemical makeup of those mixtures.

The rudimentary progress described in the JACS paper is "a good start," comments David R. Walt , a chemistry professor at Tufts University, Medford, Mass., who specializes in chemical sensors. But, he adds, a crucial capability remains to be demonstrated: whether the sensor ar-ray's response can be used to train a computational network to recognize color patterns so that it can identify the components of an unknown solution.

"We have not done that yet," says team member Neikirk, but "it's next on the platter."

Ron Dagani