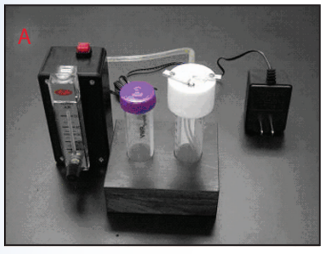
NCTR: Research Developing Inexpensive Sensors

The National Center for Toxicological Research (NCTR) sensor technology research focuses on food decomposition and detection of explosives. These technologies can be used in counterterror warning systems. The food decomposition sensors have the added value of quality assurance for routine use along the food distribution chain.

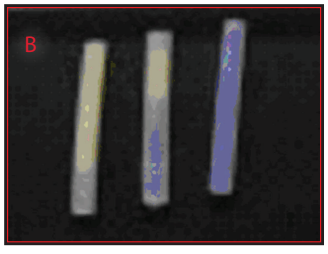
Colorimetric Food Decomposition Sensors

NCTR's sensor technology originated in 1990 as an effort to develop an objective instrumental system to augment FDA's human sensory seafood analysis. The second generation product was a food quality indicator kit (as pictured below) that could assay seafood freshness, with quantitative precision and low unit cost, on the dock or in the food processing plant.

To determine the food quality, air is bubbled through a solution containing extract drilled from the frozen food product. As the air passes through a clear "straw" filled with colored dye, the dye changes color. The length of the color change indicates the extent of spoilage. FDA inspectors, long haul freighters, and bulk food buyers can use the kit to guarantee that products are fresh upon delivery.



A) Food Quality Indicator Kit.



B) Straw indicators, left to right, show increasing spoilage by the length and intensity of blue color.

A consumer spin-off of the color change concept involves dye impregnated in a strip, laminated string, wafer, or spot inside a clear plastic food package. The sensor changes color if the food is spoiled, giving the consumer an indicator of food quality without having to open the package or thaw the product. The reaction works at temperatures as low as -70° C. U.S. and foreign patent applications have been filed.[1]

The photograph below shows a version with a wafer inside the package, under the clear plastic wrapping. With a yellow wafer outside the package for comparison, one can see how the color changes. The wafer inside the packaging is blue because the frozen shrimp, which look okay, are actually decayed.

Blue (inside the package) = slightly spoiled;
Yellow (outside the package) = good

NCTR scientists have developed a whole family of chemically sensitive "spots" that can be printed on the inside of clear food packages. These change color to indicate bacterial decomposition of protein in egg products, oxygen-induced rancidity of fats in frozen fish, baby formulas, potato chips, or souring of fresh vegetables.

Inexpensive Explosive Sensors

An extension of the colorimetric technology can be applied for low part-per-million level detection of explosive vapors. Prior to use, an inspector's white gloves are impregnated with a sensing dye and sprayed with an acidic solution of diphenylbenzidene. The photograph to the right shows the results of an inspector wiping his hand across a cardboard box containing explosives. The blue spots indicate explosives are present.

A noncolorimetric sensor system using carbon nanofibers embedded in a polymer spot is much more sensitive than the gloves. It gives a vast difference in electrical resistivity (six to nine orders of magnitude dynamic range) upon exposure to vapors from the explosives. Embedded in the tip of a sniffer probe or wand, this cheap and ultra-sensitive detector is as sensitive as a bomb-sniffing dog and as simple to use as an ohmmeter. To use the device, zero the meter and begin wanding packages, especially at their seams. If the meter ever leaves zero, calmly set that package aside, step away from it, and telephone the bomb squad! Then, rezero the meter or replace the sensor tip to use the device again.

A slightly variant concept is being developed that uses a fluorescent color changing reagent. The idea is to impregnate the reagent, which is clear in ordinary sunlight, onto airplane ticket stubs and mailing labels. These can be read under UV light to show fingerprints of persons who have recently touched explosives.

Without obviously changing any element in ticket design, the explosive-sensing fluorescence technology can be extended for automatic, mass application in the public transportation industry. Ticket stub readers at airport departure lounges, bus depots, train stations, and subway turnstiles can be modified to sense fluorescence and give an instant warning—a survey for explosive exposure applied to every passenger on the system.

Colored spots on inspector's glove indicate presence of explosives.

[1]D. Miller, J. Wilkes, E. Conte,"Food Quality Indicator Device ." Submitted as a full U.S. Patent Application No. 09/116,152 filed July 16, 1998 and international patent number WO 99/04256, January 28,1999 (published). Submitted for several specific country patents in 1999, including Korea, Japan, Canada, Finland, Australia, New Zealand, and Mexico.

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