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SENSORS & ANALYSIS

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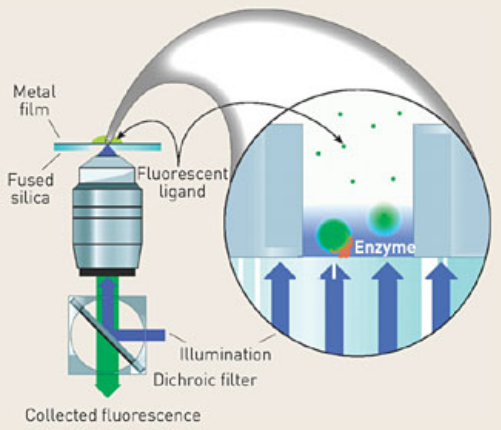
In the analytical realm this year, a method for optical detection of the activities of single molecules, even when present at relatively high concentrations, was devised by Watt W. Webb and Harold G. Craighead of Cornell University and coworkers [*Science*, **299**, 682 (2003)]. Their "zero-mode waveguides"--holes in a metal film that are smaller than the wavelength of light--create detection volumes as small as 10 zeptoliters (1 zL = 10^{-21} L), the smallest ever reported.



SINGLE-MOLECULE DETECTOR Webb, Craighead, and coworkers developed this "zero-mode waveguide" technique for detecting single-molecule phenomena. © SCIENCE 2003

In another development of miniature proportions, Thomas G. Thundat and Lal A. Pinnaduwage of Oak Ridge National Laboratory and the University of Tennessee created a highly miniaturizable device for detecting plastic explosives with a sensitivity higher than that of any existing technology [*Appl. Phys. Lett.*, **83**, 1471 (2003)]. Large and expensive instruments like ion mobility spectrometers are currently used to detect plastic explosives in airports and other locations.

Two groups--Bernhard Lendl at Vienna University of Technology, in Austria, and coworkers and Staffan Nilsson at Lund University, in Sweden, and coworkers--developed the first surface-enhanced Raman spectroscopy techniques for measuring vibrational spectra of samples in tiny airborne droplets [*Anal. Chem.*, **75**, 2166 and 2177 (2003)].

Jason B. Shear's group at the University of Texas, Austin, achieved capillary electrophoresis separations in less than 10 microseconds--about 100-fold faster than any previous CE procedure [*Proc. Natl. Acad. Sci. USA*, **100**, 3853 (2003)]. The technique makes it possible to separate and analyze reaction intermediates and other transient

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chemical species.

A sensitive and selective colorimetric sensor for lead developed by Yi Lu and a coworker at the University of Illinois, Urbana-Champaign, could lead to a long-sought simple and inexpensive test kit for leaded paint [*J. Am. Chem. Soc.*, **125**, 6642 (2003)]. The sensor--based on gold nanoparticles and a selective DNAzyme--may also prove useful for measuring other metals, nonmetals, and compounds.

The first electrochemical DNA analysis technique that's sensitive, specific, reagentless, and reusable was developed by Chunhai Fan, Kevin W. Plaxco, and Alan J. Heeger of the University of California, Santa Barbara [*Proc. Natl. Acad. Sci. USA*, **100**, 9134 (2003)]. It could provide the basis for a portable, continuous analyzer for medical and military applications.

Chad A. Mirkin of Northwestern University and coworkers devised an ultrasensitive protein detection method that may be useful in cancer diagnosis [*Science*, **301**, 1884 (2003)]. The target protein is captured by antibodies, separated magnetically, and identified by encoded DNA, which provides an amplifying effect.

Combining fluorescent monomers and polymers that undergo temperature-induced phase transitions in water produces "by far the most sensitive fluorescent molecular thermometers known," according to Seiichi Uchiyama and Kaoru Iwai of Nara Women's University, in Japan, and coworkers [*Anal. Chem.*, **75**, 5926 (2003)]. The devices can potentially be used as biological nanosensors or as monitors of microreactor temperature.

In microfluidics, a device that combines cell handling, rapid-cell lysis, electrophoretic separation, and fluorescence detection was developed by J. Michael Ramsey and coworkers at Oak Ridge National Laboratory [*Anal. Chem.*, **75**, 5646 (2003)]. The apparatus makes it possible to analyze single cells at rates of seven to 12 cells per minute--more than 100 times faster than the standard CE approach. Potential applications include clinical diagnosis and fundamental studies on cell-to-cell heterogeneity.

JIFFY TUBE **Hourglass-shaped capillary made it possible for Shear and coworkers to achieve microsecond electrophoretic separations.** UNIVERSITY OF TEXAS, AUSTIN, PHOTO

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