SCIENCE

EDITORIAL

Instrumentation

Science again presents its annual issue on instrumentation. There are many reasons for this regular occurrence, but the key ones are that almost everyone in the experimental sciences depends substantially on instrumentation in research and everyone wants to know what is new.

In addition to reviewing some excellent research, the articles in this issue illustrate some important aspects of modern instrumentation. First, instrumentation is driven by technology. Development and commercialization of new technologies make many of these instruments possible. In many cases, it is the components of homebuilt instruments that are commercial, but there is no question that the instruments would not exist without the industry that produced these components. Second, we see the impact of the instrumentation on the science. New instrumentation allows us to do our work better (sometimes even to do it at all) and to do it faster and more efficiently.

High-accuracy mass measurement of peptides and proteins is critical as we begin to characterize these important molecules of life. Chait and Kent describe advances that have allowed the measurement of mass spectra with picomole sensitivity. What is needed to do the job right is both volatilization as well as accurate mass measurement. Laser vaporization coupled with time-of-flight mass spectrometry and electrospray coupled with quadrupole mass filters can give an accuracy of one part in 10^4, thereby making extremely useful information accessible.

Farrow and Rakestraw describe the use of optical degenerate four-wave mixing to detect trace molecular species. This technique is based on the interaction of three input laser beams of the same frequency with a nonlinear medium to produce a coherent signal beam. As the laser frequency is scanned, the mixing is enhanced wherever a molecular resonance occurs, and so the signal is bright against the background, which allows rejection of potential interfering radiation and the possibility of remote measurement. The technique is coherent and highly selective, and thus especially well suited for studying combustion processes.

The new atomic microscopies are becoming increasingly important in our ability to look directly at the surfaces of condensed phases. Radmacher, Tillmann, Fritz, and Gaub point out that in atomic force microscopy, soft is hard. They discuss the problems and advances in imaging soft samples with the atomic force microscope. With hard, conventional samples, surface topology and tip geometry are important. With soft, noncrystalline samples, viscoelastic properties are important. Studies are discussed in which local viscoelasticity and friction coefficients of monomolecular Langmuir-Blodgett films can be mapped out on a nanometer scale.

McConnell *et al.* describe the cytosensor microphysiometer. This is a potentiometric sensor that uses silicon chip technology to enable two-dimensional scanning of cell response to chemical species by means of a light beam. Typically, metabolism in cells produces acid, so the pH is an excellent marker of metabolic change. Because pH change can be sensed rapidly with this instrument, it is possible to examine many cells more or less simultaneously. Thus, one can quickly determine the response to a large number of possible receptor ligands or chemicals. This type of rapid screening is very different from other more conventional methods and will have an important effect on strategies for drug research. Applications to some particular receptors are discussed.

Stoutland, Dyer, and Woodruff describe new developments in ultrafast infrared spectroscopy. A major advantage of infrared spectroscopy is its specificity for particular species or functional groups. In addition to the elegant technique of upconverting a slice of the full infrared peak, thus applying the time constraint after absorption, a method of providing a tunable, ultrafast, probe pulse is also possible. Advances in technology have permitted infrared spectra to be obtained with a time resolution of picoseconds. Studies of CO binding in cytochrome c oxidase, of CO binding to copper as opposed to iron, and of electron transfer in mixed valence compounds are discussed.

The increase in productivity, both in the ability to solve new problems and the ability to solve problems more efficiently, is the mark of a great deal of current science. Much of this increase comes from new instrumentation. Fortunately, we have recognized the advantages of a continuing investment, both at the research and development level as well as commercially. We must be conscious of the value of this investment. It provides much of the lifeblood of our science.

John I. Brauman