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SCIENCE

Instrumentation

Development of new equipment and new techniques continues to create opportunities in established fields and to make accessible new types of investigations. Currently, much of this progress is dependent on the availability of moderately priced computer power. Another important trend is the coupling of two or more instrumental components to achieve greater analytical capabilities.

In this issue Arndt-Jovin and colleagues describe powerful new tools for studying biological objects. Fluorescent imaging combines the use of lasers and fluorogenic substrates. In some instances the fluorophores are attached to monoclonal antibodies. Resultant fluorescent light is detected by electronic devices, and the information can be displayed on a video screen and stored. Advantages of the system include: (i) particular cellular constituents can be visualized in the presence of a large excess of other components; (ii) quantification is feasible at low concentrations because of the inherent sensitivity of emission as opposed to absorption; and (iii) discrete cellular components below the diffraction-limited resolution of the light microscope are detectable.

Ellis and colleagues describe equipment that can monitor surface reactions on a millisecond time scale. This represents an improvement in capabilities on the order of 10^3. The experiments are performed under high vacuum and include use of a molecular beam that is adsorbed on a surface, high-resolution electron energy spectroscopy that employs many detectors, and a mass spectrometer to monitor products. Results include data about the role of transient species and elementary reaction pathways on a surface. Effects of surface topography defects, promoters and inhibitors, and composition on such reactions can be obtained.

Highly monochromatic dye lasers can selectively ionize elements and even their isotopes. This capability, when combined with mass spectrometry, introduces an entirely new procedure for chemical analysis. Fassett and colleagues discuss procedures for use of the combined techniques for analysis of inorganic mixtures by isotope dilution. They suggest that isotope abundance sensitivities in excess of 10^{12} may be available and that elemental analysis by isotope dilution may be feasible at the subpicogram level.

Another example of the value of combining two techniques is provided by Eachus and Olm. They studied the effects of radio-frequency excitation on the intensity of electron spin resonance signals, in effect, performing simultaneous nuclear magnetic resonance and electron spin resonance experiments. Applications include the study of lattice defects in silver halides when transition metal ions are added as dopants.

Slow neutrons have a wavelength of about 1 angstrom and are scattered by matter in ways that differ from x-rays or electrons. Moon describes how these properties are used in studies by an increasingly large and diverse group of investigators. The disciplinary mix includes condensed matter physics, 35 percent; chemistry, 23 percent; materials science, 16 percent; polymer science, 13 percent; and biology, 13 percent.

In the creation of synthetic genes, 100 and more nucleotides are sequentially brought together. If the yield for each step were, for example, 95 percent, little final product would be obtained. Caruthers describes a synthetic process with coupling efficiencies of 99.5 to 99.8 percent. A nucleotide can be added every 6 minutes, with use of either manual procedures or a gene machine.

Hirschfeld, a longtime observer of the evolution of instrumentation, points to the importance of continuing trends in computers. Increasing power and lower costs make it inevitable that computers will play more roles in instrumentation and in the conduct of experimental procedures. Artificial intelligence will be more effectively applied. Sensors will be adjuncts to the computer in contrast to the case now, where the sensor usually comes first.—PHILIP H. ABELSON