The 1983 Pittsburgh Conference: A Special Instrumentation Report

If the 34th annual Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy were to be described in one word, that word might well be "sober." Admittedly, attendance, the number of exhibitors, and the number of booths were all up again, with attendance breaking the 20,000 mark for the first time to reach 21,728. Gone, however, were the magicians, the man in the alligator suit, and the festive air that permeated last year's exposition. Gone, too, was the rosy optimism of last year that had large instrument companies predicting substantial increases in sales despite the recession. Those large increases never materialized and, in a few product lines, sales even dropped slightly. For the coming year, the companies are expecting only very modest sales increases. There were also few really new instruments at the show. Most companies seemed to be consolidating the advances they had made in recent years. About the only discernible trends were the introduction of color graphics on video display units—a cosmetic addition, albeit a useful one in many cases—the appearance of less expensive models in many product lines, and the presence of more products with a biological orientation. Both the potential and the need for innovation were still present, however, as witnessed by some statistics disclosed by Hewlett-Packard Company. Last year, fully 50 percent of that company's instrument sales were accounted for by products introduced within the past 3 years. Furthermore, the company devoted to research and development a sum equivalent to about 10 percent of total sales, a figure substantially higher than that for U.S. industry as a whole. Comparable figures may vary slightly from company to company within the industry, but they tell much the same story. Gone forever, it would seem, are the days when a Beckman DU or a Spectronic 20 can dominate sales in a particular category year in and year out with no significant changes.

Quadrupoles Appear in New Instruments

The quadrupole is a simple, inexpensive way to separate ions by mass. In recent years, quadrupoles have begun to appear much more frequently, either alone in relatively inexpensive instruments for mass spectroscopy (MS) or as one or more of the segments of an MS/MS instrument that provides both sample separation and identification. At this year's Pittsburgh Conference, there were three new instruments that wed a quadrupole to another instrument to facilitate chemical analysis. Two of the instruments represent important advances in MS technology.

The quadrupole is a simple mass filter constructed by placing four stainless steel rods in close proximity lengthwise to form a passageway for ions. When both a radio-frequency (RF) current and a direct-current (d-c) voltage are applied to the rods, ions passing between them travel in a complicated pathway. For any given combination of RF current and d-c voltage, only ions of one mass-to-charge (m/z) ratio will follow a stable trajectory all the way through the center of the quadrupole; all others will hit the sides of the instrument and be captured. By scanning through various combinations of RF current and d-c voltage, it is possible to produce a conventional mass spectrum. The quadrupole gives results that are nearly as good as those produced by a magnetic sector instrument, but it is smaller and less expensive. It is also much simpler to operate under computer control.

Donald J. Douglas and his colleagues at Sciex Inc. of Thornhill, Ontario, have combined a quadrupole with an inductively coupled plasma (ICP) source to produce a new instrument called the Elan ICP/MS Elemental Analysis System. The ICP is a source that has sparked new interest in atomic emission spectroscopy (AES), which identifies elements by their optical emissions after they have been excited in the plasma (*Science*, 24 Mar. 1978, p. 1324). In the ICP, argon flows through a cylindrical quartz "torch," the end of which sits inside an induction coil. An RF current through the coil creates the plasma by accelerating argon to high energies; it also confines the plasma. A second argon stream carries a nebulized sample into the plasma, where the high temperatures (6000 to 10,000 K) ionize the individual atoms. In AES, light emitted by the excited ions is measured photometrically. Douglas's group in Thornhill, however, has found a proprietary way to channel the ions into a quadrupole detector.

Much of the first work on ICP/MS was conducted by Stan Houk and Allen Gray of Iowa State University. They used a small orifice, 0.003 inch in diameter, to allow some of the ionized atoms to escape the plasma and enter the quadrupole. Since the length of the orifice must be less than its diameter, they used a very thin sheet of platinum foil to separate the plasma from the MS vacuum system, which meant they had to work at low pressures. But the small orifice plugged up frequently and the thin foil could not withstand the heat from the plasma.

Douglas was able to get around this problem by making use of a cryogenic pumping system developed at Sciex. They use an orifice ten times as large, 0.03 inches in diameter, so they can use a much thicker metal foil that will withstand the heat better; they can also work at atmospheric pressure. A mechanical pumping system is used to withdraw about 10^{-4} of the atoms in the plasma through the orifice into the interface; the cryogenic pump then pumps a small fraction of the gas in the interface into the spectrometer; a supersonic expansion nozzle cools the ions to about 14 K before they enter the quadrupole.

The foremost advantage of ICP/MS compared to ICP/AES, says Douglas, is simplicity. Optical spectra contain many different emission lines for each element, so that the spectrum is complex and there is a great deal of overlap between