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NASA TECH BRIEF

Improved Photoionization Mass Spectrometer

The analytical method of photoionization mass spectrometry has been used in the past for research in photoionization effects, ionization-potential determination, ion-neutral reactions, and ion-formation kinetics. However, practical application of this method to the analysis of gases has been severely hampered by intensity problems, particularly when monochromators have been employed to obtain dispersed ultraviolet radiation. The use of a monochromator is, nevertheless, essential if one major advantage of the photoionization method is to be retained: the ability to set the maximum ionization energy extremely accurately, by adjusting the ionizing wavelength.

A photoionization mass spectrometer has been developed which lessens the intensity problem and thus increases the potential for application of photoionization mass spectrometry to gas analysis.

Experiments have shown that sensitivity of the technique is limited by interference from higher-order spectral lines and from scattered ultraviolet light, both of shorter wavelength than desired. Such radiation, inherently generated by the monochromator diffraction grating, causes considerable activation of molecules with ionization energies above the selected maximum photon energy. These problems have been greatly reduced by adding a filter to the monochromator. This filter may consist of a selectively transmitting gas cell, a thin film or mirror of selective reflectivity, or a predispersing grating. Any of these well-known devices, together with a monochromator and a mass spectrometer, forms a novel and powerful analytical tool.

In a typical problem such as the analysis of a mixture of nitrogen and carbon monoxide gases, expensive, high-resolution mass spectrometry was formerly necessary, since both gases yield a mass peak very close to $M = 28$. Photoionization mass spectrometry previously has been able to detect a minimum concentration of only about 0.5% (5000 parts per million) carbon monoxide in a nitrogen atmosphere; with the addition of an argon gas filter, a concentration of less than 100 parts per million of carbon monoxide is detectable. Similar improvements have been noted in various equivalent cases.

Notes:

1. For background information on this innovation and on the technique of photoionization mass spectrometry, the following documentation may be obtained from the source in Note 2.

   NASA-CR-71210 (N66-19636)
   Physics of Planetary Atmospheres-IV,
   Gas Analysis by Photoionization Mass Spectroscopy

   NASA-CR-66100 (N66-27231),
   Development of a Mass Spectrometer Employing a Photoionization Source

2. The following documentation may be obtained from:

   Clearinghouse for Federal Scientific and Technical Information
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.65)

   Reference:
   NASA-CR-1018 (N68-17329), Improvement and Optimization of a Mass Spectrometer Employing a Photoionization Source

(continued overleaf)

Patent status:

This invention is owned by NASA, and a patent application has been filed. Royalty-free, nonexclusive licenses for its commercial use will be granted by NASA. Inquiries concerning license rights should be made to NASA, Code GP, Washington, D.C. 20546.

Source: W.P. Poshchenrieder, J.A.R. Samson, and P. Warneck of GCA Corp. under contract to Langley Research Center (LAR-10180)