

## PLASMA SAMPLING--A VERSATILE TOOL IN PLASMA CHEMISTRY

H. Helm,\* T. D. Märk, and W. Lindinger  
Institut für Experimentalphysik, Universität Innsbruck, Austria

Plasma sampling had its early beginnings in experiments concerned with the nature of anode and cathode rays. Although these experiments date back to the end of the last century (1-4) it was not until the fifties that the sampling technique was recognized as a powerful tool in plasma diagnostics. In 1957 Pahl and Weimer started systematic studies on the dependence of the wall current in a positive column on the discharge parameters and analyzed with a magnetic mass spectrometer the positive ion current penetrating through a tiny orifice in the wall of the discharge vessel (5-7).

This new technique proved to be of general use and was soon applied to the study of other discharge regimes as well as to decaying plasmas and flames. The extension of the sampling technique to the analysis of neutral ground state and excited species present in plasmas was straightforward and enjoys today widespread application as a diagnostic tool. Recent interest in the ion and neutral chemistry of the upper atmosphere has led to the development of balloon- and rocket-borne sampling systems satisfying specific requirements.

The exciting prospect about the sampling technique is that one has direct access to the identity of the plasma species, and indeed many new species such as  $H_3^+$  have first been detected in this way (8).

The sampling technique is however not free from complications and drawbacks. The problems arise from the fact that the particles under study have to be drawn from the unperturbed plasma into an analyzer. They may thereby suffer gross changes in their energy distribution and under circumstances even change their identity in reactive collisions within the analyzing system.

The aim of the current paper is to outline various problems associated with sampling techniques and show how they may be avoided or resolved

in various types of applications.

\* Current address: SRI International, Molecular Physics Laboratory,  
Menlo Park, California 94025.

#### References

1. A. Schuster, Proc. Roy. Soc. 47 (1890) 526.
2. J. J. Thomson, Proc. Camb. Phil. Soc. 9 (1897) 243.
3. W. Wien, Wied. Ann. 65 (1898) 440.
4. P. Lenard, Wied. Ann. 45 (1898) 504
5. P. Pahl, Z. Naturforsch. 12a (1957) 632; 18a (1963) 1276.
6. U. Weimer, Z. Naturforsch. 13a (1958) 278.
7. M. Pahl and U. Weimer, Z. Naturforsch. 12a (1957) 926; 13a (1958) 50, 745, 753.
8. A. J. Dempster, Phil. Mag. 31 (1916) 438.