Measurement of Vapor Pressures at High Temperatures Using X-Ray Induced Fluorescence

J. J. Curry [C, S]
NIST, Quantum Measurement Division, Gaithersburg, MD, U.S.A.
jjcurry@nist.gov

W. P. Lapatovich
Consultant, Boxford, MA, U.S.A.

E. G. Estupinan
OSRAM SYLVANIA INC, Beverly, MA, U.S.A.

A. Henins
NIST, Quantum Measurement Division, Gaithersburg, MD, U.S.A.

S. D. Shastri
Argonne National Laboratory, Advanced Photon Source, Argonne, IL, U.S.A.

We have used x-ray induced fluorescence (XRIF) to determine absolute vapor pressures in sealed ceramic and quartz cells at high temperatures (900 K to 1400 K). The elemental content of the vapor is measured directly by observation of characteristic x-ray fluorescence induced by high-energy synchrotron radiation (>50 keV). Partial pressures are determined from assumed partitioning of those elements across various molecular species. In some cases, the partitioning is trivial or is known with some confidence. In other cases, the expected partitioning is complex and has never been experimentally validated. In such cases, additional measurements are required to fully determine all of the thermodynamic parameters involved. Even then, the elemental densities as a function of temperature put important constraints on the unknown parameters. The x-ray induced fluorescence method makes it possible to use completely sealed vapor cells so the experiments may be conducted in a constant volume, defined temperature mode with the total mass content of the cells remaining unchanged with time. In general, XRIF is suitable for vapor pressures equal to and exceeding (by a few orders of magnitude) the maximum pressures for which effusion methods are useful. We'll discuss our measurements and analysis of a few rare-earth metal-halide systems, including systematic errors.