1 of 1

Y/DK-977

Code

Presented at the 41st ASMS Conference on Mass Spectrometry

EXPERIMENTAL AND THEORETICAL RELATIVE ION YIELDS FOR GLOW DISCHARGE MASS SPECTROMETRY

*R. W. Smithwick III, D. W. Lynch, and J. C. Franklin

Oak Ridge Y-12 Plant[1]
Analytical Services Organization
Martin Marietta Energy Systems, Inc.
Oak Ridge, Tennessee 37831-8189

Previous Work

The purpose of this work is to improve quantitative elemental analyses by glow discharge mass spectrometry (GDMS) by predicting the individual sensitivities of the elements. The results reported on this poster reinforce recently published work (JASMS 1993, 4, 278-285). Relative ion yields (RIYs), defined in that work, were experimentally measured for 19 elements in NIST steel reference materials (#661-665) using both pure argon and argon containing 1 vol % H_2. RIYs were also theoretically calculated using the following equation:

$$RIY_s = \frac{(Mass\ factor)_s\ (Ionization\ factor)_s\ (Atomic\ weight)_{Fe}}{(Mass\ factor)_{Fe}\ (Ionization\ factor)_{Fe}\ (Atomic\ weight)_s}$$

The mass factor, taken to be $1 - e^{-0.04\,AW}$, was believed to result mostly from the mass dependence of analog detection. The predicted use of ion counting to eliminate the need for this factor is one of the interesting aspects of the present paper.

The thermodynamic ionization factor, $1/[1 + e^{+(EA+IP-\mu)/kT}]$, involves the electron affinity and the first ionization potential for each element, as well as a chemical potential (μ = 9. ev), the Boltzman constant k, and a temperature (T = 14000 K). The atomic-weight factors are necessary to convert atom % to wt %.

When the theoretical RIYs were plotted versus the experimental RIYs, the correlation was found to be strong when the measurements were made using argon that contained 1 vol % H_2.

Present Results

The following results were obtained using a Concept S32 high-resolution glow discharge mass spectrometer (manufactured by Kratos Analytical, Ltd.):

1. When ion counting was used, theoretical RIYs without a mass-dependent factor correlated well to experimental RIYs when argon was used that contained 1 vol % H_2.

2. When Inconel-steel reference materials (4.5 to 46 wt % Fe) were measured using argon containing 1 vol % H_2, the theoretical RIYs (previously used for low-alloy steels) correlated well. This indicated that the same RIYs apply to a wide variety of steels.

3. When a steel standard was measured using argon containing 5 vol % helium, the results were nearly the same as the results obtained when pure argon was used. This indicated that the physical effect of thermal conductivity (which is similarly high for both H_2 and He compared to argon) does not account for the improved correlation observed for argon containing 1 vol % H_2.

[1]Managed by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy under contract DE-AC05-84OR21400.

DATE
FILMED
1/25/94
END