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Shadow spectral imaging of absorbing layers in a transversely heated graphite atomizer
Part 2. Molecules and condensed-phase species

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Abstract

The dynamics of formation and dissipation of chloride, nitrate and sulfate matrix vapors in a transversely heated graphite tube atomizer (THGA) with and without integrated platform was investigated with the use of multi-channel atomic absorption spectrometry and the shadow spectral imaging technique. It is shown that non-uniform heating of the tube walls and platform in the furnace radial cross-section causes vapor transfer from atomizer bottom to less heated sides of the tube and platform. This transfer in the atomizer cross-section can be an additional reason for lower level of matrix interferences in the THGA and is a prerequisite for explosive atomization of some elements that appear as absorbance spikes. The cross-sectional structures of molecular layers and the cloud of condensed phase particles are highly inhomogeneous, resulting in absorbance gradients up to 0.2–0.5 mm^{-1}. These structures differ significantly from those observed earlier in end-heated atomizers. Local vortices of the sheath gas, toroid-shaped and bridge-like structures of vapor layers were observed in the atomizer volume. The role of light scattering on the finally dispersed condensed phase particles in the transverse heated furnace is greater than that in the end heated atomizers because of near axis location of the cloud.

Keywords: Atomic absorption spectrometry; Transversely heated graphite atomizer THGA; Shadow spectral imaging; Matrix vapor

1. Introduction

Investigation of spatial structure of analyte and matrix vapors is a powerful tool for understanding basic processes occurring in electrothermal atomizers [1,2]. Documenting the nonuniformities in the absorbing layers is also important from fundamental point of view since detected absorbances depend not only on the number of absorbing species along the probing beam but also on their distribution over the beam cross-section [3,4]. Numerous spatially resolved investigations of end heated atomizers are summarized in reviews [5,6] and the latest books on analytical atomic spectrometry [7–9]. Currently different vaporization/atomization devices are being developed that are based on transversely heated graphite atomizer (THGA). Detailed information about dynamics of spatial structure of analyte atoms in laboratory made [10,11] and commercial [12,13] THGAs was obtained. It was found that spatial dynamics of formation and dissipation of absorbing layers in the THGAs in many cases differ significantly from that of end heated furnaces. The main reason is pronounced thermal inhomogeneity of transversely heated furnace in the radial cross-section that results in atomization mechanism occurring via intermediate stage of analyte condensation on the colder sides of the THGA. In atomic absorption spectrometry, the measured analytical signal is always a difference between the gross absorbance and nonspecific absorbance. Therefore fundamental characterization of non-selective absorbance produced by molecules and/or condensed phase species is equally important. It was shown [14,15] that spatial structures of non-selectively absorbing layers are highly non-uniform in THGAs and depend on variety of conditions: chemical composition of a matrix, addition of a modifier, ingress of oxygen into the atomizer, etc. Any systematic investigation of spatial dynamics of molecular and condensed phase species layers is absent this

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