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Digital imaging of formation and dissipation processes for atoms and molecules and condensed-phase species in graphite furnace atomic absorption spectrometry: A review

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Abstract

This is a review of our recent work in the use of a CCD-based digital imaging system for the shadow spectral digital imaging (SSDI) of boron, aluminium (spike formation), and condensation of vapour of selected analytes, matrices, and chemical modifiers in graphite furnace atomic absorption spectrometry (GFAAS). The use of a charge-coupled device (CCD) camera has enabled a number of processes in the Massmann-type GFAAS to be more thoroughly investigated than has been previously possible. The SSDI technique has been used to obtain spatially and temporally resolved distributions of atoms, molecules and condensed-phase species generated in a graphite furnace as a result of processes such as vaporization, atomization and condensation. The application of this technique to the investigation of atomic and molecular species of boron has helped in elucidating the mechanism of vaporization and atomization of boron. Thermal dissociation of boron oxide species results in the formation of BO(g) and its loss from a graphite furnace at temperatures below the atomization temperature of boron. The atomic boron signal is the result of desorption of boron atoms from the decomposition of condensed-phase boron carbide. Studies using the CCD imaging of atomic and molecular species of aluminium in a graphite furnace have resulted in a mechanism being proposed for aluminium atom spike formation and for dissipation of aluminium atoms in the graphite furnace, aluminium atom spikes formed from gaseous Al2O precursors, this reaction being triggered by the formation of a condensed-phase Al4C3 melt. Finally, the SSDI technique has been used to further our knowledge and understanding of light-scattering of microparticles produced by condensation of vapours of selected analytes, matrices and chemical modifiers. The spatial and temporal non-uniformity of condensed-phase particle clouds are attributed to thermal expansion of gas, gas flow patterns and temperature gradients in the vapour phase and in the heated graphite tube which develop in the Massmann-type graphite furnace.

Keywords

Atomization, Charge-coupled device, Condensation, Graphite furnace, Light-scattering