Mem. S.A.It. Vol. 7, 230

Memorie della
Supplementi

Voigt a-damping parameter of the spectral lines emitted by a plasma flame and a plasma column generated by a microwave at atmospheric pressure

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Abstract. Atomic emission spectroscopy is a passive spectroscopy technique widely used in the diagnosis of plasmas which does not alter the internal kinectic of the discharge during the measurement process, under high pressure conditions. Line profiles are adequately fitted by a Voigt function. One of the parameter which characterizes these spectral lines is the *damping* or *Voigt-a parameter*. In this work a simple method for obtaining experimentally the value of the *a parameter* of the spectral lines emitted by an argon plasma generated at atmospheric pressure is presented. The value indicates the proportion existing between the Lorentz and Doppler components of the total profile of the line.

Key words. Damping parameter-Microwave plasmas-Atmospheric pressure-Spectral line broadening-Atomic emission spectroscopy

1. Introduction

Atomic emission spectroscopy (AES) is a non-disruptive method to perform plasma physics diagnosis, by collecting and analyzing the radiation emitted by the plasma. Under high pressure conditions, line profiles are adequately fitted by a Voigt function, which is the convolution of a Gaussian and a Lorentzian function. One of the parameter which characterizes these spectral lines is the *damping* or *Voigt-a parameter*, which is equal to $a = (\Delta\lambda\sqrt{\ln 2})/\Delta\lambda_D$, where $\Delta\lambda_L$ is the Lorentzian broadening of the spectral line, given by the sum of the *Stark broadening* (interaction with the charged particles) and the so-called *pressure* or *van der Waals broadening* (interaction of the excited atoms with the dipole induced on the neutral disturbers). $\Delta\lambda_D$ is the *Doppler broadening* of the spectral line, caused by the movement or the thermal agitation of the emitting particles. This broadening depends on the kinetic temperature of the particles originating it.

The value of the *a-parameter*, which cannot be resolved analytically due to its complexity, is an indication of the relative importance of each broadening components. This parameter supplies information about the quantity of the local collision interactions compared to the other processes that take place into the plasma.

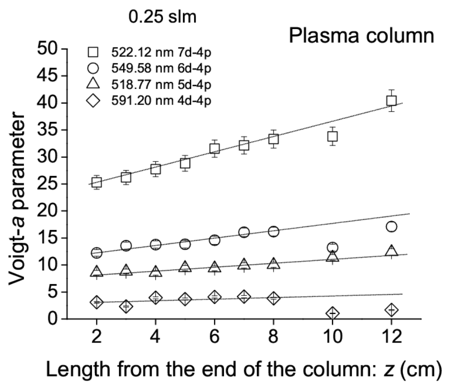

Fig. 1. *a-parameter* values for different spectral lines from a plasma column.

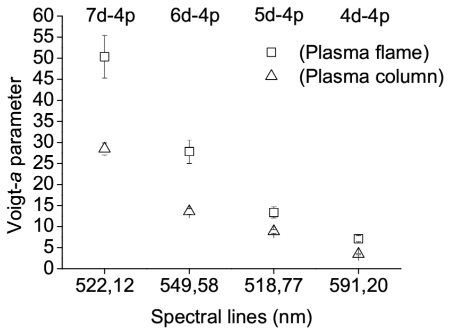

Fig. 2. *a-parameter* values for different spectral lines from a plasma column and a flame (100 W, 0.25 slm)

In this study a simple method to obtain experimentally the *Voigt-a parameter* value of the spectral lines emitted by two kinds of SWDs, a column and a flame, generated by microwave energy at atmospheric pressure is presented.

2. Experimental procedure and results

The experimental radiation emitted by the discharges has been studied. It has been collected in the laboratory by an optical fibre, and using a monochromator has been decomposed in the different spectral lines. The Lorentzian contribution has been obtained from the deconvolution of these spectral profiles (using a commercial computational program) and the Doppler width from the temperature of the gas; this temperature was measured using the rovibrational spectra of the OH species, which is present as an impurity in the discharge. With these broadening values the *a-parameter* has been calculated; the indetermination of this parameter's value being a 5%.

In the plasma column the calculated *a-parameter* values are within interval values registered in the literature (Hart et al. 1986). For the most internal lines, which are less affected by the plasma particle collisions, it has been found that the Doppler broadening was predominant compared to the Lorentz one ($a < 1$). The spectral lines involving high-lying levels the *a-parameter* is more sensitive to the changes of the electron density, which increases along the plasma column from the exciter, than for the lines close to the ground state (Calzada et al. 1996) (Figure 1).

It has been also observed that the *a-parameter* value is higher for the lines emitted from the plasma flame than from the plasma column (Figure 2). This is a reflection of the increase of the electronic temperature and density in the flame and consequently of the excitation capacity of this discharge in relation to the column (Calzada et al. 2002).

Acknowledgements. This work was carried out with the support of the Ministry of Science and Technology (Spain) and the European Community (FEDER funds) in the framework of project No. FTN2002-02595.

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