Journal of Research in Physics Vol.28, No. 3, 247-250 (1999)

EXPERIMENTAL STARK SHIFTS OF SEVERAL Ar II SPECTRAL LINES

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1. INTRODUCTION

Only few papers deal with Stark shift (*d*) measurements of the singly ionized argon (Ar II) spectral lines (Konjević & Wiese 1990, and references therein). The aim of this paper is contribution to the knowledge of the Stark shift values at 22 500 K electron temperature and 1.9 x 10^{23} m^{-3} electron density. We have measured Stark shift values for four Ar II spectral lines that belong to four various tansitions. For the 471.4 nm Ar II spectral line measured values does not exist, to the knowledge of the authors. Our measured *d* values are compared with the existing experimental and theoretical data.

2. EXPERIMENT

The modified version of the linear low pressure pulsed arc (Djeniže et al 1989, Djeniže et al 1998) has been used as a plasma source. A pulsed discharge has been driven in a quartz discharge tube of 5 mm inner diameter and had an effective plasma length of 5.8 cm. The tube has end-on quartz windows. On the opposite side of the electrodes the glass tube was expanded in order to reduce sputtering of the electrode material onto the quartz windows. The working gas was argon and helium mixture (72% Ar + 28% He) at 130 Pa filling pressure in flowing regime. Spectroscopic observation of isolated spectral lines were made end-on along the axis of the discharge tube. A capacitor of 14 μF was charged up to 2.5 kV giving discharge current of up to 6.1 kA (determined using coil Rogovski). The line profiles were recorded by a shot-by-shot technique using a photomultiplier (EMI 9789 QB) and a grating spectrograph (Zeiss PGS-2, reciprocal linear dispersion 0.73 nm/mm in the first order) system. The exit slit (10 μm) of the spectrograph with the calibrated photomultiplier was micrometrically traversed along the spectral plane in small wavelength steps (0.0073 nm). The photomultiplier signal was digitized using oscilloscope, interfaced to a computer. A sample output, as example, is shown in Fig. 1.

The measured profiles were of the Voigt type due to convolution of the Lorentzian Stark and Gaussian profiles caused by Doppler and instrumental broadening. A standard deconvolution procedure (Davies & Vaughan 1963) was used to obtain the Stark width of the He II P-α spectral line. The procedure was computerized using the least square algorithm.

The Stark shifts were measured relative to the unshifted spectral lines emitted by the same plasma (Purić & Konjević 1972). The Stark shift of a spectral line can be measured experimentally by evaluating the position of the spectral line centre recorded at two various electron density values during the plasma decay. In principle, the method requires recording of the spectral line profile at the high electron density (N_1) that causes an appreciable shift and then, later, when the electron concentration has dropped to the value (N_2) at least an order of magnitude lower. The difference of the line centre positions in the two cases is Δd, so that the shift d_1 at the higher electron density N_1 is:

$$d_1 = N_1\, \Delta d \,/\, (N_1 - N_2).$$

In the case of our experiment the estimated error by the Stark shift determination was within ± 25%.

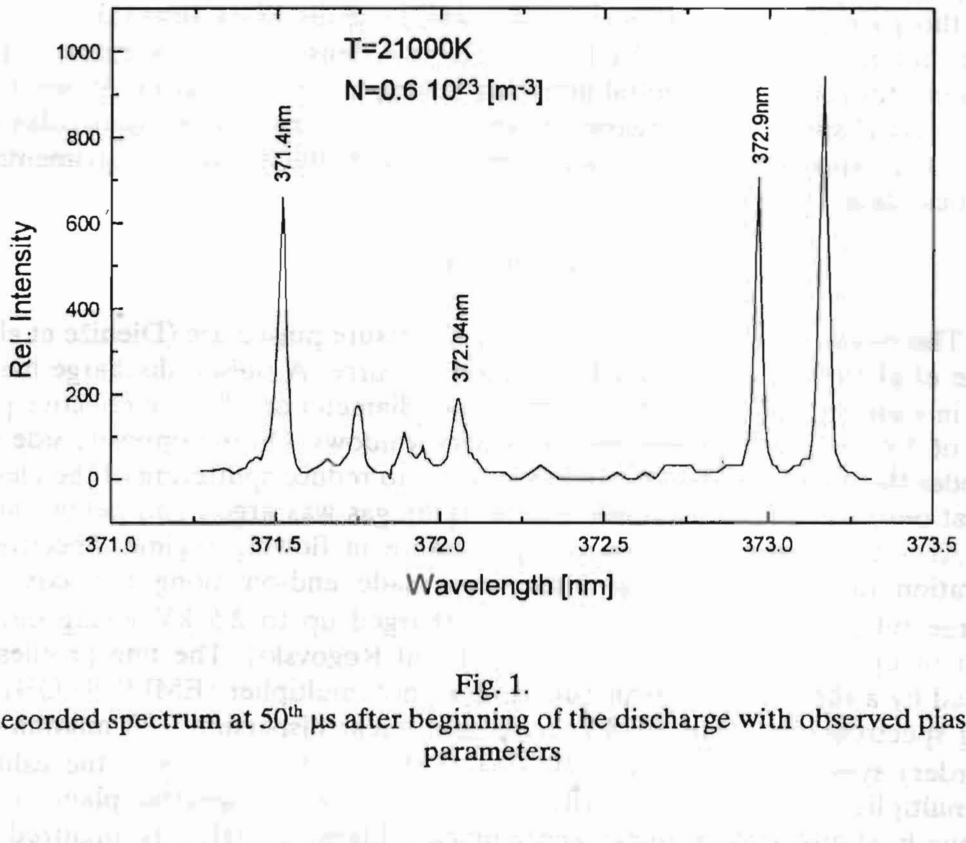

Fig. 1.
Recorded spectrum at 50th μs after beginning of the discharge with observed plasma parameters

The plasma parameters were determined using standard diagnostic methods. The electron temperature was determined from the Boltzmann-slope of seven Ar III spectral lines (330.2, 331.1, 335.9, 334.5, 333.6, 248.9 and 250.4 nm) within ± 10% accuracy. The necessary atomic data were used from Wiese et al. (1969). Electron density decay was obtained using the method of the laser interferometry with the 632.8 nm He-Ne laser line and, also, on the basis of the the Stark width of the convenient P-α (468.57 nm) spectral line from the He II spectrum within ± 7% accuracy.

3. RESULTS

Our results are presented in the Table 1 at T = 22 500 K electron temperature and N = 1.9 x 10^{23} m $^{-3}$ electron density, together with transition arrays and accuracy

(Acc.). The positive sift is toward the red.

Transition	Muttiplet	λ (nm)	d (nm)	Acc. (%)
3d–4p	$^4D - ^2D^0$ (3)	371.47	0.005	20
4p–5s	$^4P^0 - ^4P$ (42)	372.04	0.032	15
4s–4p	$^4P - ^4S^0$ (10)	372.93	- 0.003	15
4p–4d	$^4D^0 - ^4F$ (56)	357.66	0.013	25

Table 1.

4. DISCUSSION

In order to allow easy comparison among existing (measured and calculated) Stark shift values, we report in Fig. 2. variations of *d* with the electron temperatures for a given electron density equal to 10^{23} m^{-3}.

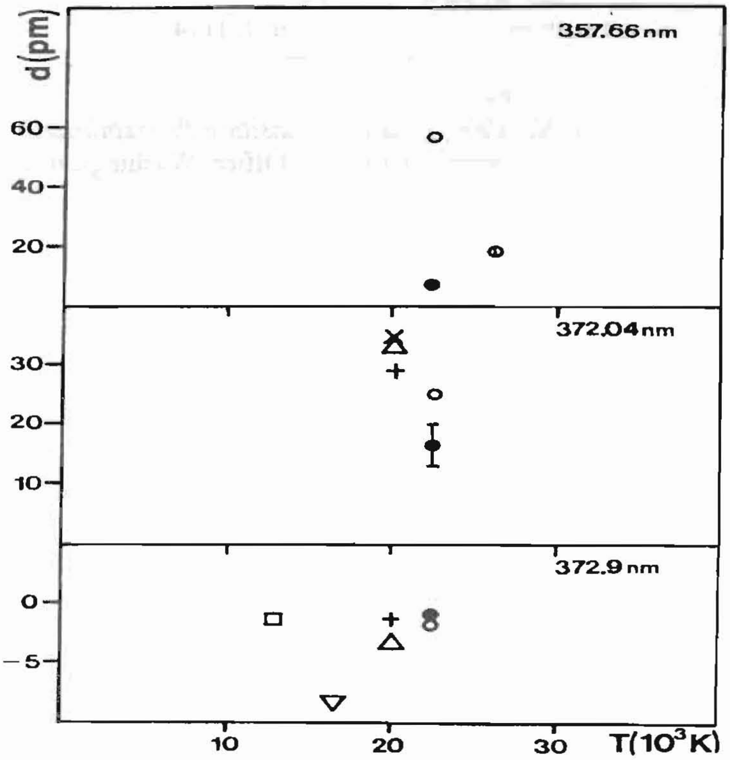

Fig. 2.

Stark shift (d) dependence on the electron temperature at 10^{23} electron density. Measured values: ●, this work; 0, Aparicio et al. 1998; ±, Dzierzega & Musiol 1994; ϕ, Djeniže et al. 1989; ∇, Labat et al. 1974; Δ, Morris & Morris 1970. Theoretical values: +, Griem 1974 and x, Kršljanin & Dimitrijević 1989.

One can conclude that theoretical values exist only for the 372.04 nm and 372.93 nm spectral lines. It turns out that in the case of the 372.93 nm line the experimental and theoretical *d* data show mutual agreement in the vicinity of 21 000 K electron temperature. In the case of the other two spectral lines (372.04 nm and 357.6 nm) the existing *d* values show evident mutual scattering.

Acknowledgment: This research is a part of the project "Plasma Spectroscopy" supported by Ministry of the Science and Technology of the Republic of Serbia.

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