

STARK WIDTH AND SHIFT OF C I 538.0 nm SPECTRAL LINE

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1. INTRODUCTION

The shape of asymmetrical Stark broadened spectral line profiles of neutral emitters, are well theoretically described by $j_{A,R}(x)$ function (Griem, 1974). The Stark broadening parameters - electron impact half-halfwidth w_e , electron impact shift d_e and ion broadening parameter A for C I spectral lines are theoretically calculated only in Griem (1974). The width and shift (at the halfwidth), including the ion broadening, of spectral lines of neutral emitters are given as Griem (1974) :

$$w_{th} = 2w_e(1 + gA_N)N_e 10^{-16}$$

$$d_{th} = (d_e \pm 3.20A_N g_1 w_e)N_e 10^{-16}$$

where $g = 1.75(1.75 - 0.75R)$, $g_1 = g/1.75$, $A_N = AN_e^{1/4}10^{-4}$ and Debye shielding parameter $R = 0.090N_e^{1/6}T^{-1/2}$. w_e , d_e and A are calculated (Griem, 1974) for $N_e = 10^{16} \text{ cm}^{-3}$.

There are only a few experimental papers (Nubbemeyer and Wende, 1969; Miller and Bengston, 1970; Goly *et al.*, 1983; Jones and Wiese, 1984) which are dealing with the Stark broadening of C I 538.0 nm, and only one (Miller and Bengston, 1970) reports on the shift of this line.

In this paper we report on the widths and shifts of C I 538.0 nm spectral line emitted from the plasma of a wall-stabilized arc at two electron densities. Obtained results are compared with the theoretical (Griem, 1974) and other experimental results (Nubbemeyer and Wende, 1969; Miller and Bengston, 1970; Goly *et al.*, 1983; Jones and Wiese, 1984).

2. EXPERIMENT

A detailed description of experiment and spectroscopic measurements one can find elsewhere (Mijatović *et al.*, 1995ab). The main characteristics of this experiment and line shape measurements are :

- the wall-stabilized arc operated in argon under atmospheric pressure was used as a plasma source.
- The spectroscopic measurements are performed end-on. Due to the arc geometry and the way of introducing and exhausting gas mixture (64 % Ar, 32 % CO₂ and 4 % H₂), the near-electrode cold layer effects on the observed lines were minimized.
- As a reference light source for the shift measurements the hollow-cathode discharge lamp operated in pure hydrogen was used. The shift of C I 538.03 nm line was measured from the unshifted H₂ 537.84 nm line.
- 1-m monochromator, photomultiplier and computer-controlled digital oscilloscope were used for spectroscopic measurements. The photomultiplier signals averaging technique was applied which considerably increased signal-to-noise ratio.
- Self-absorption of spectral lines was checked and found to be negligible.
- The electron densities were measured from the Stark width of hydrogen H_β line (Vidal *et al.*, 1973).
- The plasma temperatures were determined from plasma composition data evaluated following procedure described in White *et al.*, (1958).
- The deconvolution procedure (Mijatović *et al.*, 1993) for Stark broadened asymmetrical $j_{A,R}(x)$ profile and Gaussian, caused by Doppler and instrumental broadening, was applied. In this way only the Stark widths of measured profiles were obtained.
- In order to determine position of unshifted H₂ 537.84 nm line, the profiles measured from reference source were fitted to Gaussian. In Fig. 1 is given an example of measured profile of C I 538.034 nm spectral line together with the reference line.

3. RESULTS AND DISCUSSION

In Table 1 the results of measured plasma parameters (N_e , T) and Stark parameters - line widths w and shifts d are given together with the results of the other experiments (Nubbemeyer and Wende, 1969; Miller and Bengston, 1970; Goly *et al.*, 1983; Jones and Wiese, 1984). The experimental results are compared to the theoretical ones (Griem, 1974). It could be seen from the Table that the agreement between experimental results of measured widths is (inside 10 %) good with the exception of the results obtained by Nubbemeyer *et al.* (1969) whose measured values are about 30 - 40 % lower than the others. The comparison with the theory shows that theory predicts slightly smaller widths than were obtained in the experiments.

Measured shifts of C I 538.0 nm line in this work are rather small (see Table). The estimated error in the shift determination is about 0.003 nm. It could be seen from the comparison with the theory that the agreement with the another experimental result (Miller and Bengston, 1970) is good, but both of them are with large error in the shift determination (30 % and more), so certain quantitative conclusion about the agreement with the theory could not be drawn.

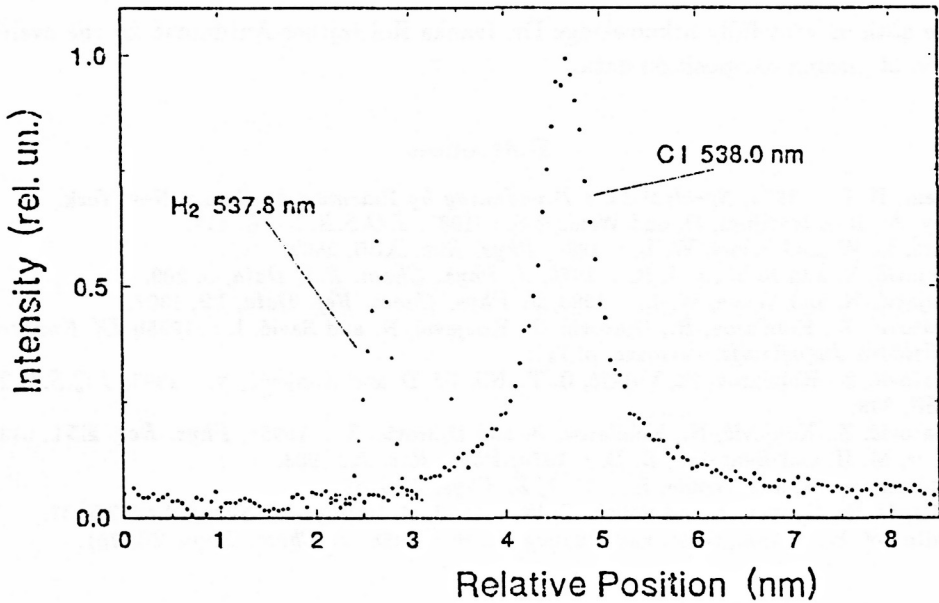


Fig. 1. An example of measured C I 538.0 nm line from the arc, and H₂ 537.8 nm line from the reference source.

Table 1 Experimental widths w and shifts d for C I 538.0 nm line: I – Nubbemeyer & Wende 1969, II – Miller & Bengston 1970, III – Goly *et al.* 1983, IV – Jones & Wiese 1984. Ratios of measured and theoretical widths w_{th} and shifts d_{th} are given.

N_e [$10^{22} m^{-3}$]	T [K]	w [nm]	w/w_{th}	d [nm]	d/d_{th}	Acc.*	Ref.
2.20	9900	0.058	1.03	0.0092	0.69		This work
2.85	10300	0.077	1.04	0.0081	0.61		
1.2 - 1.7	9000 - 11750	0.022 - 0.148	0.78 - 0.73			C	I
10	11000	0.3	1.09	0.03	0.62	C	II
0.91 - 5.96	9000 - 11600	0.025 0.150	1.10 - 0.91			B	III
7.39	11600	0.229	1.06			A	IV

* Accuracy is taken from critical reviews (Konjević and Roberts, 1976; Konjević and Wiese, 1990).

Acknowledgements

The authors gratefully acknowledge Dr. Ivanka Holclajtner-Antunović for the evaluation of plasma composition data.

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