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STARK PARAMETERS TEMPERATURE DEPENDENCE OF THE Ar I 425.9 nm LINE

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1. INTRODUCTION

In this paper we report the results of experimental study of the Ar I 425.9 nm line (4s' $[1/2]^0$ - 5p' [1/2]) Stark width and shift temperature dependence with an emphases to the low temperature region where broadening parameters are relatively small and difficult to measure. These results are used for the testing of the theory in the low temperature region. The linear dependence of the Stark broadening upon electron density has been tested and proven in a number of experiments (Griem, 1974; Konjević and Roberts, 1976; Konjević et al., 1984; Konjević and Wiese, 1974, 1990). These parameters upon electron temperature in a wider temperature range has been tested only in a few cases (for example see Shumaker, 1974). Our results in conjunction with other experimental data obtained at higher electron densities and temperatures are also used for the testing of semiclassical theory Griem (1974) in a wider temperature range.

2. EXPERIMENTAL

For the plasma source an atmospheric pressure wall stabilized electric arc is used. For diagnostic purposes 4 % H_2 is mixed with pure argon. The current of 30 A was supplied to the arc by a current-stabilized power supply with stability of 0.3 %. The plasma observations were performed side-on with a 1m monochromator and photomultiplier tube. The signals from the photomultiplier were led to the digitizing oscilloscope working in the averaging mode. For the shift measurements, the low pressure argon lamp with microwave excitation is used as a source of unshifted line. The light from the arc plasma and from the reference source is focused on to the entrance slit of the monochromator alternatively by means of light chopper. The stepping motor of the monochromator, light copper and oscilloscope are controlled by the personal computer. The same computer is used for data acquisition.
An electron density (N_e) in the range (0.47 - 3.50) $\times$ 10^22 m^{-3} is determined from the width of Balmer H_β line (Vidal et al., 1973). The electron temperature (T_e) in the range (8900 - 11000) K is obtained from plasma composition data evaluated as described in White et al. (1958).

3. RESULTS AND DISCUSSION

The spectral line profiles, recorded side-on from the stabilized arc are Abel-inverted (Djurović et al.). The argon line Abel profiles are treated by computer program developed for deconvolution of Gaussian (instrumental and Doppler) profile and $j_{A,R}(x)$ profile (Mijatović et al., 1993) to obtain measured Stark full-halfwidth, w_m, data. The spectral line profiles from the reference are fitted by least square method to Gaussian profiles. The shift of plasma broadened lines is measured at the halfwidth, d_{mh}, and at the peak, d_{mp}, of line profile. All experimental widths and shifts are corrected for Van der Waals broadening (Griem, 1964). The experimental results and comparison with semiclassical theory data together with corresponding electron density and temperature are given in Table 1. The estimated errors for N_e, T_e, w_m, and d_m are ± 8-11 %, ± 2-3 %, ± 5-10 % and ± 4-12 % respectively from the largest to smallest electron density and temperature. The theoretical widths and shifts are corrected for Debye shielding effect (Griem, 1974).

Table 1. Measured values and comparisons with the theory (Griem, 1974).

N_e (10^{22} m^{-3})	T_e (K)	w_m (nm)	w_m/w_t	d_{mh} (nm)	d_{mh}/d_{th}	d_{mp} (nm)	d_{mp}/d_{tp}
3.50	11070	0.071	0.70	0.038	0.75	0.036	0.70
3.40	11040	0.070	0.70	0.037	0.75	0.035	0.69
3.30	10980	0.066	0.69	0.036	0.76	0.034	0.69
3.30	10890	0.062	0.68	0.034	0.75	0.032	0.69
2.70	10690	0.057	0.72	0.030	0.77	0.028	0.65
2.40	10540	0.049	0.71	0.025	0.73	0.024	0.69
2.00	10310	0.042	0.74	0.023	0.79	0.021	0.72
1.70	10120	0.035	0.73	0.019	0.75	0.018	0.72
1.40	9930	0.030	0.75	0.016	0.79	0.016	0.77
1.05	9680	0.024	0.80	0.012	0.77	0.012	0.76
0.90	9470	0.019	0.75	0.009	0.71	0.009	0.71
0.70	9260	0.014	0.70	0.008	0.75	0.008	0.74
0.60	9130	0.012	0.73	0.007	0.77	0.007	0.76
0.47	8900	0.010	0.81	0.006	0.85	0.006	0.83

The comparison of the experimental and theoretical data in Table 1 shows that experimental results for both, widths and shifts, are systematically smaller than semiclassical theoretical data (Griem, 1974). In order to extend the temperature region of the comparison and to compare with other experiments (Gericke, 1961; Powel, 1966; Schulz and Wende, 1968; Bues et al., 1969; Morris and Morris, 1970; Musielok et al., 1976; Klein and Mainers, 1977; and Jones et al., 1986) the ratios w_m/w_t and d_{mp}/d_{tp} are introduced together with our data in Figs. 1 and 2 respectively.

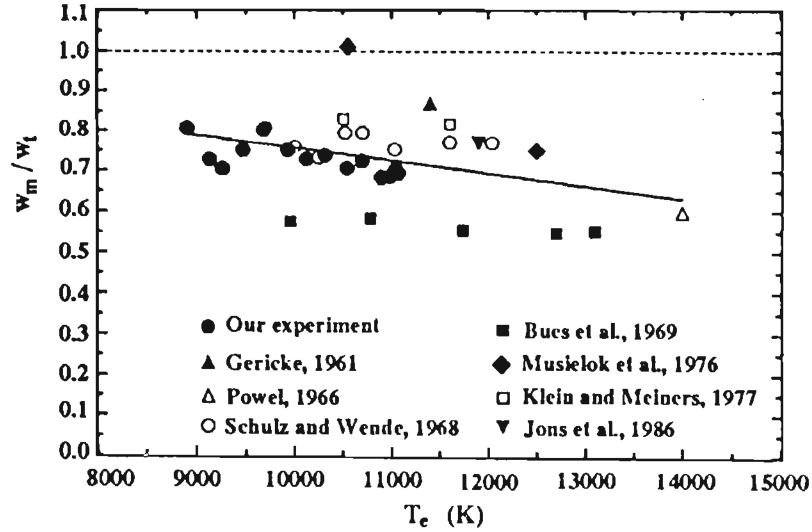

Fig. 1 The ratio of measured and theoretical widths w_m/w_t vs electron temperature T_e.

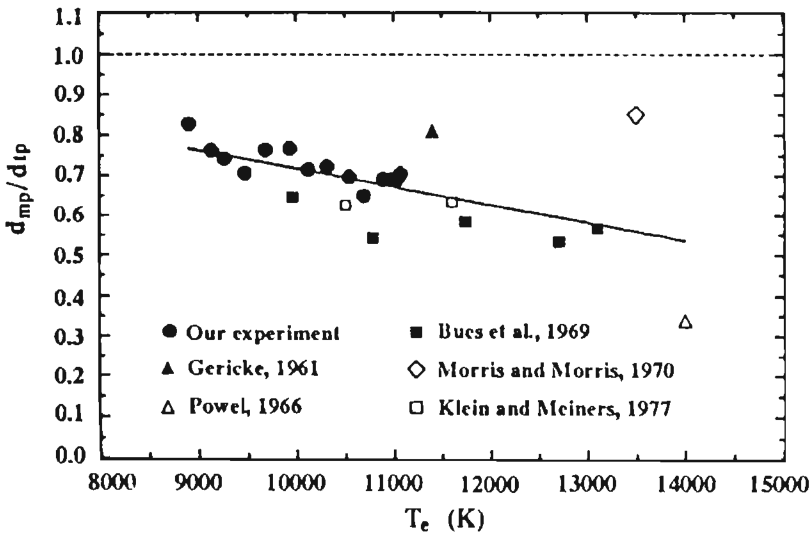

Fig 2. The ratio of measured and theoretical shifts at the peak d_{mp}/d_{tp} vs electron temperature T_e.

In spite of the scatter of the ratios w_m/w_t and d_{mp}/d_{tp} the comparisons in Figs. 1 and 2 show systematic discrepancy between experiment and theory (Griem, 1974) with experimental results being always smaller. These comparisons indicate that further improvements of theory are required.

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