Publ. Astron. Obs. Belgrade No. 84 (2008), 305 - 308 *Contributed Paper*

THE TEMPERATURE DETERMINATION OF THE ATMOSPHERIC ARGON PLASMA JET

S. DJUROVIĆ, Z. MIJATOVIĆ, M. ĆIRIŠAN, B. VUJIČIĆ, R. KOBILAROV and T. GAJO
Department of Physics, Faculty of Sciences,
Trg Dositeja Obradovića 4, 21000 Novi Sad, Serbia
E–mail: djurovic@uns.ns.ac.yu

Abstract. In this paper we report the results of plasma jet temperature determination from the Stark shift of Ar I 415.86 nm spectral line. For the plasma jet formation modified wall stabilized electric arc was used.

1. INTRODUCTION

In this experiment modified wall stabilized electric arc as a plasma source was used. This kind of arc works in DC regime with typical current of few tens of amps, usually less than 100 A. High arc current can be realized in pulses, using power from AC network and these currents can reach values up to 1000 A or more. Increase of arc current increases also plasma electron density and temperature. In order to form pulsed plasma jet in free space, outside of the plasma column, high current pulses was applied to the wall stabilized arc and added to DC current. For this purpose one of stabilized arc ends was opened. This is illustrated in Fig. 1.

The electric circuit was described earlier (Djurovic et al. 2004, Ćirišan et al. 2006). Here will be given only short description. Wall stabilized arc in DC regime is supplied from current stabilized electrical source with the current stability of 0.3 %. Maximum current which can be reached is 30 A. This current provides plasma electron temperature between 10000 and 11000 K and electron density of few times 1016 cm-3 (Djurović et al. 1997, 2002). Higher values of these plasma parameters demand higher discharge current. One way to do this economically is to apply high current pulses superposed to the DC current. This can be done using civil AC network of 220 V in combination with appropriate electronic circuit. In combination with appropriate resistor it provides current pulses lasting 8 ms, with the peak current of 170 A. Every 16th of 50 Hz cycle is used to produce high current pulse. So, repetition rate of the high current pulses is 3.12 Hz. This repetition rate is low enough not to affect temperature of the arc walls which were water cooled in usual manner. The pulsed current was measured by means of Rogowski coil, and monitored by digital oscilloscope.

In this paper we report the results of plasma jet temperature determination from the Stark shift of Ar I 415.86 nm spectral line.

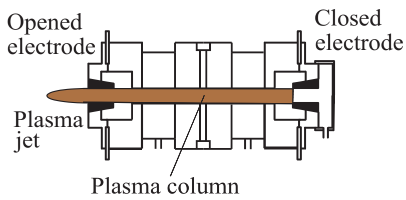

Figure 1: Illustration of plasma jet formed in free space.

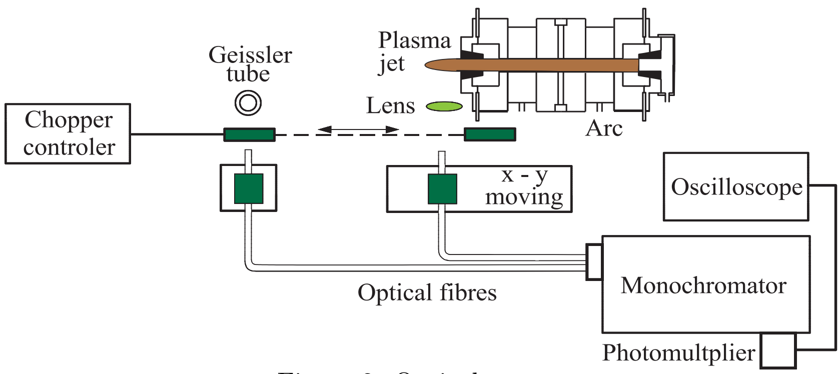

Figure 2: Optical system.

2. OPTICAL ASSEMBLY FOR PULSED PLASMA JET OBSERVATION

In order to record optical emission from plasma jet, optical system shown in Fig. 2 was assembled. It enables recording of spatially resolved integral intensity of the plasma jet radiation. X-Y moving system provides recordings of integral optical emission at different positions. Optical signals are led to the digitizing oscilloscope through the optical fibre monochromator and photomultiplier.

An example of time resolved recorded optical signal is given in Fig. 3. In the figure one can see pulsation in the optical intensity. It is consequence of the pressure pulsation inside of the stabilized arc after the current pules was applied.

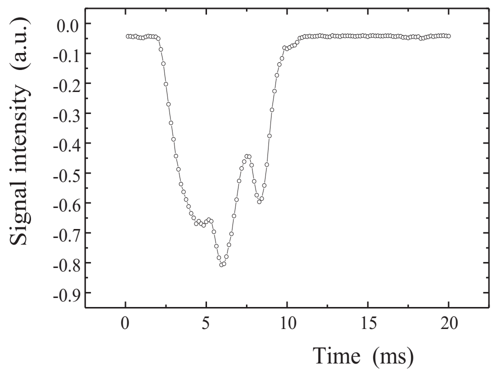

Figure 3: Time resolved optical signal.

3. THE TEMPERATURE DETERMINATION

The temperatures at different times of the plasma jet decay were determined from the measured dependence of Ar I 415.86 nm line shift on the temperature (Djurović et al. 2002, Popenoe and Shumaker 1965) (Fig. 4).

A low pressure argon Geissler tube is used as a reference source of unshifted argon spectral line. For the shift measurements, the light from both plasma jet and reference source is directed onto the entrance slit of the monochromator by optical fibers (see Fig. 2). In this way by using a chopper, light from the reference source or from plasma jet can be detected alternatively by the photomultiplier placed at the exit slit of the monochromator. Both signals are recorded at each wavelength step along the investigated wavelength interval.

An example of recorded Ar I 415.86 nm spectral line from the plasma jet and reference source is shown in Fig. 5. This profile corresponds to the time of maximal emissivity and it was recorded at the position on the jet axis close to the exit hole of the arc.

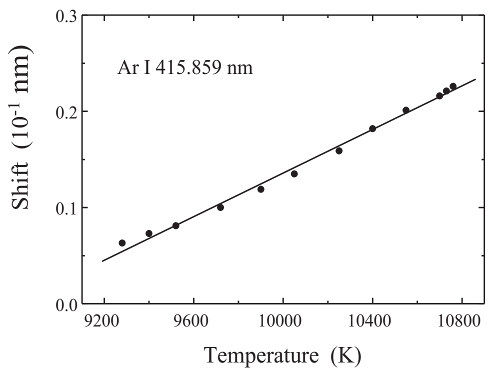

Figure 4: Dependance of the shift of 415.86 nm line on the temperature (Djurović et al. 2002, Popenoe and Shumaker 1965).

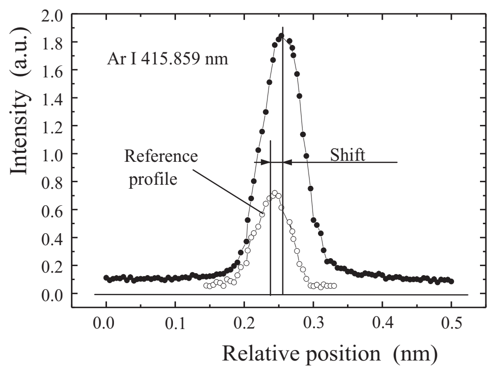

Figure 5: An example of the recorded profiles from plasma jet and reference source.

Combining the results of measured shifts with graph in Fig. 4, the temperatures of plasma jet for various times of plasma decay were obtained. This is presented in Fig. 6. The values on the horizontal axis correspond to the time measured from the beginning of the plasma jet formation.

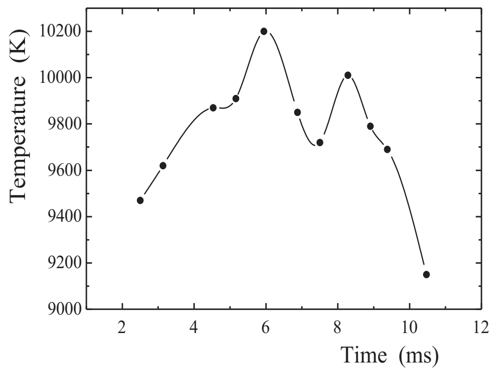

Figure 6: Temporal dependence of the plasma jet temperature.

As it can be seen from Fig. 6, the maximuma of the temperature are at 6 and 8.3 ms after plasma jet formation. This corresponds to the maximum of the plasma emissivity (see Fig. 3). At 6 ms plasma temperature reaches 10200 K, while in the later times it falls to 9000 K.

Acknowledgements

This work is supported by the Ministry of Science, Republic of Serbia, under contract No. 141024.

References

Ćirišan, M., Djurović, S., Mijatović, M., Vujičić, B. and Kobilarov, R.: 2006, *J. Res. Phys.*, **30**, 95.

Djurović, S., Mijatović, Z., Ćirišan, M., Vujičić, B. and Kobilarov, R.: 2004, *Contributed paper of 22nd SPIG*, Ed. Lj. Hadievski, p. 333.

Djurović, S., Mijatović, Z., Kobilarov, R. and Konjević, N.: 1997, *J. Quant. Spectrosc. Radiat. Transfer*, **57**, 695.

Djurović, S., Nikolić, D., Mijatović, Z., Kobilarov R. and Konjević, N.: 2002, *Plasma Sources Sci. Technol.*, **11**, 95.

Popenoe, C. H. and Shumaker J. B. Jr.: 1965. *J. Res. NBS, Phys. Chem.*, **69A**, 495.