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Proceedings

of the 9th International Conference on Fundamental and Applied Aspects of Physical Chemistry

Volume I

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A SPECTROSCOPIC INVESTIGATION OF STABILIZED DC ARGON ARC BY POWER MODULATION TECHNIQUE

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Abstract

Spatial distribution of delayed responses of argon and hydrogen spectral line and continuum intensity to square power modulation was investigated in order to get better insight into the processes occurring in argon dc arc plasma. The power was abruptly changed between stationary values, 9 and 3.5 A. For these currents steady state radial distributions of electron number density, temperature and emission intensity were measured. On part of the discharge, radial profiles the power drop and the power jump are both accompanied by intensity peaks which may be explained by displacement of the arc core axis and change in the arc core diameter during the power modulation.

Introduction

In spite of the fact that direct current argon arcs have various applications in different fields, and are intensively studied, a complete understanding of excitation mechanisms and transport processes in some types of plasma is not yet accomplished. In addition to well known plasma diagnostic techniques, these processes could be studied by monitoring the plasma behavior (spectral emission responses) during and after the interruption or modulation of plasma power. A square modulation of plasma power permits a variety of combinations of low and high current duration times thus making it convenient for studying slow processes in plasmas. The method of power modulation has often been used for studying inductively coupled plasmas [1].

This work deals mainly with delayed responses of argon and hydrogen line and background intensities, to square modulation of the arc current, in order to get better understanding of the processes in the arc column of argon dc plasma. For the above purpose, we have measured the radial distribution of electron number density, temperature and emission intensity in the plasma arc column for the arc currents of 9 and 3.5 A, between which the power was alternately switched. Electron number densities were evaluated from measured H_β line profiles, and corresponding temperatures were evaluated from measured absolute emissivity of argon line.

Experimental

A detailed description of the U-shaped dc argon arc with combined gas vortex and wall stabilization, operating at atmospheric pressure was described in reference [2].

In order to differentiate between the two sides of arc column we labeled the displacements from the arc axis with the plus (+) and minus (-) signs. The plus side is the one from which argon gas carrying aerosol is introduced into plasma. The modulation period was 250 ms with variable low current interval up to 50 ms. These modulation parameters prevent the superposition of effects coming from subsequent disturbances which means that discharge has enough time to return to stationary state before the next disturbance occurs. The time constant for a current change was better than 5 μs.

Results and Discussion

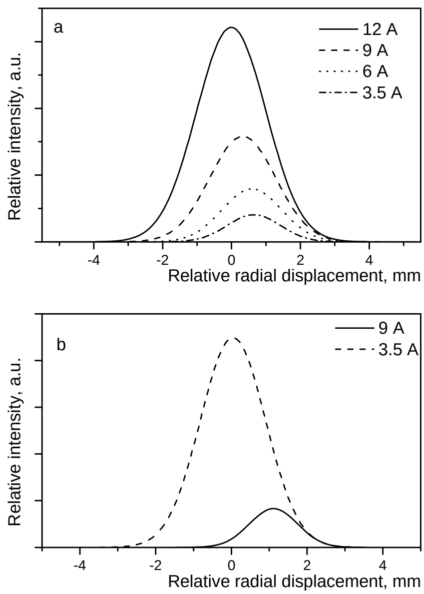

Fig. 1. Radial distribution of Ar I 696.54 nm line intensity for different arc current. Argon flow a) 2.7 L/min. b) 2.0 L/min.

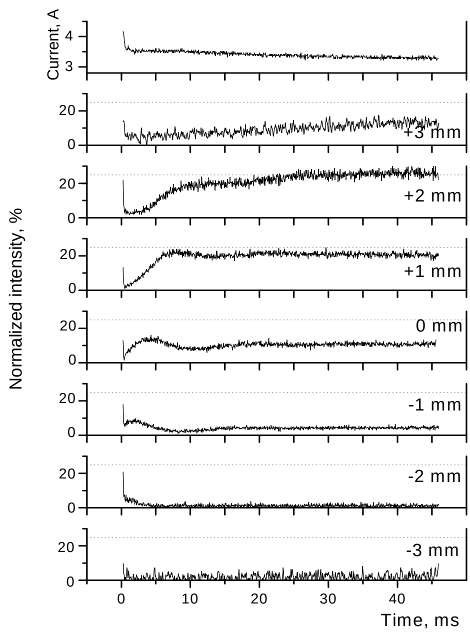

Fig. 2. Temporal evolution of the Ar I 696.54 nm spectral line after the current drop.

Radial distribution of Ar I 696.54 nm line intensity for different arc currents and 2.7 L/min argon flow is shown in Fig. 1a. The arc axis for the arc current of 12 A is represented as zero position on the x-axis. As it may be seen in Fig. 1a, by lowering the arc current the arc axis is displaced toward the (+) side while the radial dimension of the arc core is decreased simultaneously. Displacement that is even more evident is observed with lower argon flow (2 L/min), Fig. 1b. So, transition of the arc column (displacement and width change) between two stationary regimes, that correspond to upper and lower current, must be taken in considerations when we elucidate the line intensity evolution, caused by power modulation.

For elements with high ionization potential like Ar and H, and for continuum radiation there is a pronounced asymmetry in radial distribution of delayed responses to power modulation. The observed asymmetry can not be explained by asymmetry in radial distribution of plasma parameters. On part of the radial profiles, both a current jump and a current drop are accompanied by line intensity increase. As these are the same parts of radial profiles where displacement of the discharge axis takes place, it is obvious that delayed responses are actually a consequence of this displacement. To support this assumption we have varied experimental conditions that are related to the arc axis position and the arc column diameter such as carrier gas flow and arc current.

Conclusion

The obtained results were in accordance with previous conclusions: intensity peak increase and asymmetry were more pronounced for larger displacements of the arc axis. Displacement of the arc column after the power modulation must be a consequence of asymmetrical introduction of a carrier gas flow. Delayed responses of analyte line intensity (metal atoms with ionization potential usually lower than 8 eV) show completely different evolutions [2, 3] and for their interpretation, it is essential to understand the evolutions of a carrier gas and continuum, i.e. to take the arc column displacement in consideration.

Acknowledgments

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References

[1] C. E. Hensman, L. R. Drake and G. D. Rayson, Spectrochim. Acta, 1997, **52B**, 503-515.
[2] M. M. Kuzmanović, M. S. Pavlović, J. J. Savović, M. Marinković, Spectrochim. Acta, 2003, **58B**, 239-248.
[3] M. Kuzmanović, J. Savović, M. Pavlović, M. Stoiljković, A. Antic-Jovanovic and M. Marinkovic, J. Serb. Chem. Soc., 2005, **70**, 1033-1040.