THE EFFECT OF ANALYZED LIQUIDS ON THE PLASMA PENCIL DISCHARGE

Aleš Hrdlička[1], Iva Vaňková[1], Pavel Slavíček[2], Lukáš Novosád[1], Vítězslav Otruba[1], Viktor Kanický[1]

[1]Masaryk University, University Campus Bohunice,UKB, Central European Institute of Technology, CEITEC, Faculty of Science, Dep. Chemistry, Kamenice 753/5, 62500 Bohunice, Brno, Czech Republic, e-mail: 78105@mail.muni.cz

[2]Masaryk University, Faculty of Science, Dep. Physical Electronics, Kotlářská 2, 61137 Veveří, Brno, Czech Republic, e-mail: ps94@sci.muni.cz

Abstract

Plasma pencil is a barrier capacitively coupled plasma jet discharge operated in a thin quartz tube in one or two-electrode connection in the continuous or pulsed mode. It is flowed by argon, helium or another gas or gas mixture at low, atmospheric or high pressure and powered by electrical current with symmetrical sinus radio frequency 13.56 MHz. It has been extensively tested for some archaeological applications, like a cleaning of sensitive artifacts, for some industrial applications, like surface modifications and hydrofobization of textile, wood and other products, for welding of very thin steel plates as well as for analytical applications as an alternative and low-purchase excitation source for atomic emission spectrometry. In this work a plasma pencil operated at atmospheric pressure in two-electrode connection in the continuous mode and flowed by argon was used. It is demonstrated that analyzed aqueous solutions with elements in acid matrices have significant effect on both the excitation capabilities and the physical characteristics of the discharge. The fact that the presence of acids in solutions causes decrease of the measured line intensities is very good known. Significant amount of water and acids in the discharge consumes a non-negligible portion of the delivered electrical input power. The viscosity of the acids can cause a decrease of the nebulisation efficiency. Consequently, measured atomic emission lines of the elements in the introduced solutions yield lower intensities. The determination of the elements in pure water solutions shows higher sensitivity than in acid matrices. It is possible to suppose this behaviour in the case of plasma pencil. Three single element aqueous solutions were used for realization of these experiments. A 100 ml measuring flask contained magnesium, copper and zinc ions in the concentrations from 1 to 100 $mg.l^{-1}$ and added volumes of 2; 10; 20 and 50 ml of the 70 % aqueous solution of nitric acid. A sensitivity decrease ranging from about 10 to 20 % was observed for the acid concentration difference from 2 to 20 ml per 100 ml flask depending on the particular spectral line. Changes of the electron number density calculated from the Stark effect on hydrogen H_β line, excitation temperature from a set of argon lines and rotational temperature calculated from OH radicals lines give sufficient proofs for these facts. The presence of the acid had a small effect on the discharge stability in spite of the sensitivity decrease. The plasma pencil was also used for the reliable determination of zinc content in a commercial multivitamin preparation in the presence of other tablet matrix substances and proved its capability for this type of analysis.

Key words: *Aqueous solutions; concentration range; emission lines; nitric acid; plasma pencil.*

Acknowledgement

This work was supported by the projects CEITEC – Central European Institute of Technology (CZ.1.05/1.1.00/02.0068) from European Regional Development Fund and MSM0021622411 of the Ministry of Education, Youth and Sports of the Czech Republic.