Spectroscopic study of atmospheric pressure plasma jets generated with DBD in gas mixtures of He – Ar – N_2

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This work investigates the optical emission characteristics of atmospheric pressure cold plasma jets produced with a Dielectric-Barrier Discharge (DBD) in different mixtures of gases such as He - Ar, He - N_2 and He - Ar - N_2. Generated emissive species in the discharge have been identified by means of Optical Emission Spectroscopy and temporal evolution of important for biomedical application species is being studied.

Cold plasma jets running at atmospheric pressure have extensively been investigated for potential applications in biomedical fields [1, 2]. Most of those systems are DBD-based and thus discharges are sustained far away from the arc regime. We have recently reported on new jet setups fed with noble gases and supplied with audio frequency high voltage, both sinusoidal and pulsed [3-5].

In this work we study the effect of different gas mixtures on generation and temporal evolution of species in the plasma. The gas temperature is also estimated with methods based in spectroscopy [6, 8]. The experimental setup used in our research is presented in Figure 1. A pulsed positive voltage of frequency in kHz range and duty cycle in the range from 0.1 to 100% is applied between two external electrodes. By using volumetric flow controllers, the gas flowing in the ceramic tube is adjusted. Then, a DBD plasma is generated between the electrodes with a gas flow parallel to the electric field and jet propagates out of the ceramic tube, i.e. into the environmental air. By keeping the total flow rate constant at 3slm and varying the percentage of the operating gases (He, Ar, N_2), the influence of mixtures on the emission spectrum (300 to 800 nm) and gas temperature is studied.

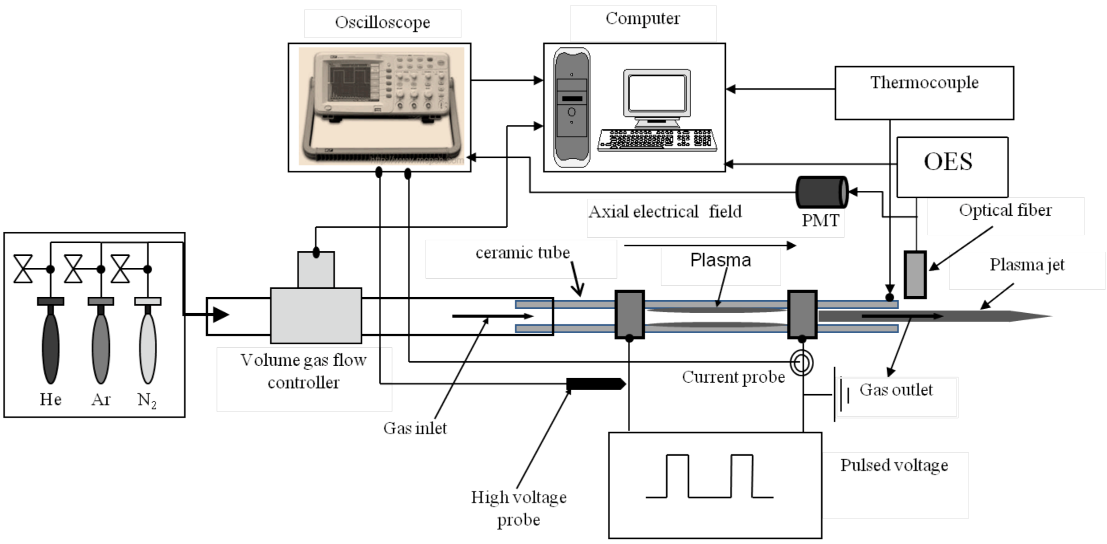

Fig. 1: Experimental setup of DBD-based plasma jet.

Figure 2 shows a typical optical emission spectrum of the plasma jet running in helium. As can be seen, besides atomic lines of helium, emission of important species such as N_2(FNS), N_2(SPS), N_2(FPS), O and OH is recorded. In the case of gas mixtures, not only species identification, but temporal evolution of these species is studied as well. An optical fiber is horizontally translated to scan the light emitted along the jet axis. The temporal evolution of this spatially-resolved emission is observed by means of UV-visible photomultiplier tube. This procedure is repeated for different mixtures of helium, argon and nitrogen gases.

The principal purpose of these studies is the determination of the optimal experimental conditions for the production of plasma jet compatible to biomedical applications. The present configuration ensures low gas temperature combined with simultaneous production of active species (O, OH, NO) that can interact with living organisms and/or tissues.

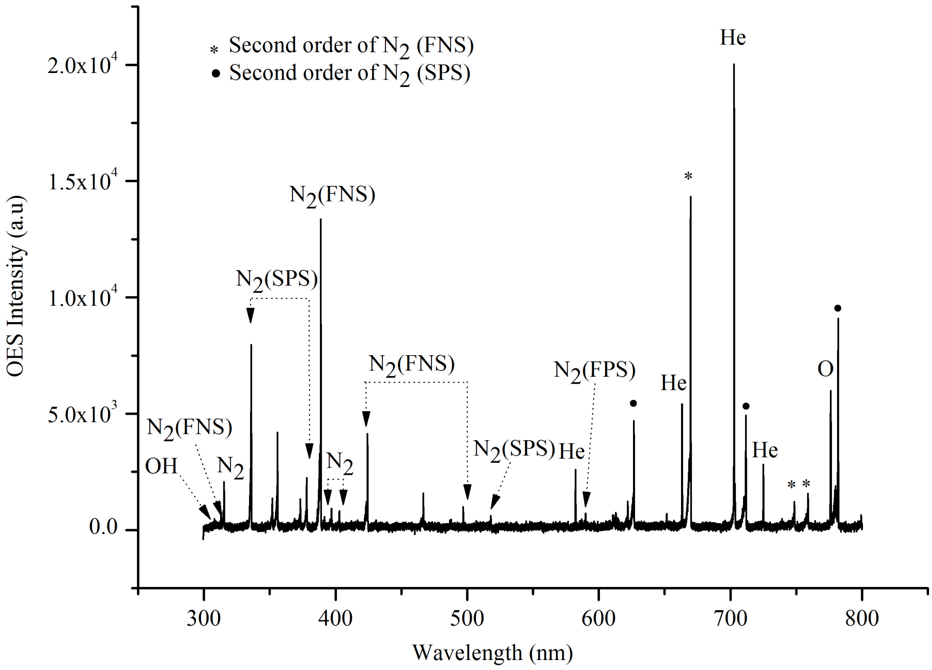

Fig. 2: Optical emission spectrum of the plasma jet flowing out into the environmental air (Helium flow rate = 3slm, V = 6kV, v = 15kHz, duty cycle = 2%).

References

[1] M. Laroussi and X. Lu, *Appl. Phys. Lett.* **87**, 113902 (2005) 3

[2] K.-D. Weltmann, T. Von Woedtke, R. Brandenburg, J. Ehlbeck, *Chem. Listy* **102** (2008) 1450-1451

[3] A. Gkelios, P. Svarnas, F. Clément, N. Spyrou, *IEEE TPS* **39**(11) (2011) 2296-2297

[4] F. Clément, P. Svarnas, L. Marlin, A. Gkelios, B. Held, *IEEE TPS* **39**(11) (2011) 2364-2365

[5] F. Clément, P. Svarnas, L. Marlin, S. Paquet, A. Gkelios, B. Held, *IEEE TPS* **39**(11) (2011) 2362-2363

[6] J L Walsh and M G Kong, *Appl. Phys. Lett.* **91**, 221502, 2007 3

[7] S. Hofmann, A.F.H. van Gessel, T. Verreycken and P. Bruggeman, *Plasma Sources Sci. Technol.* **20** (2011) 065010

[8] RP. Cardoso, T. Belmonte, P. Keravec, F. Kosior, G. Henrion, *J. Phys. D: Appl. Phys.* **40** (2007) 1394-1400