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MASS-ENERGY SPECTROMETRY DETECTION OF MOLECULE AND ATOMIC RADICALS FORMED BY μ-APPJ

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In the last few years atmospheric microplasmas draw considerable attention because of the wide spectra for their application. Large concentrations of radicals, low gas temperatures, absence of vacuum systems and possibility of localized treatment make these plasmas suitable for modification of sensitive surfaces and for biomedical applications [1, 2, 3]. Here we will present results obtained by mass spectrometry measurements of micro atmospheric pressure plasma jet. This device was previously developed by Schultz van der Gathen and coworkers [4]. One of our guidelines was to investigate possibility of applying μ-APPJ for treatment of biological samples. We have analyzed plasma products like O, N, NO, O_3 formed by μ-APPJ.

First we had to determine the calibration, reproducibility and sensitivity of our mass spectrometer. As a preliminary measure in place of a more systematic study we measured the composition of the atmosphere in our laboratory by using Hiden HPR-60 mass-energy spectrometer. Results are compared with the results of other researchers with similar systems and the data taken from the literature (Table 1.). Measured yields of atmospheric compounds agree reasonably though not perfectly with literature values. Reproducibility of the device was checked by doing the measurements consecutively during several days. Sensitivity of the mass analyzer was confirmed by measuring isotopes from the atmosphere which can be found only in traces.

Table 1. Percentages of different compounds in the atmosphere [5].

	1st day	2nd day	3rd day	4th day	Standard atmosphere	Other systems [6]
H	0.0409	0.0407	0.0465	0.0393		
H_2	0.0080	0.0189	0.0115	0.0163		
^{14}N	1.4458	1.5015	1.4279	1.4040		
^{15}N	0.0085	0.011	0.0137	0.015		
^{16}O	0.4162	0.4385	0.3945	0.3947		
OH	0.1309	0.1555	0.1548	0.1529		
H_2O	0.55	0.52	0.59	0.79	0.4	
$^{28}N_2$	74.16	73.72	73.36	73.20	78.08	68.71
$^{29}N_2$	0.57	0.59	0.649	0.636	0.566	
O_2	20.50	20.83	21.16	21.03	20.94	30.11
^{36}Ar	0.0086	0.0088	0.0438	0.0085	0.0031	0.0054
^{38}Ar	0.0033	0.0052	0.0027	0.0046	0.0006	0.0006
^{40}Ar	1.6158	1.6808	1.6704	1.7106	0.93	1.10
^{84}Kr	0.0977	6.82E-4	0.00102	0.0574	0.65E-4	1.62E-4

In our diagnostics of the μ-APPJ we scanned masses of neutrals from 1-50 amu at fixed electron energy of 70 eV and, also, we scanned distribution of neutral atoms for electron energies from 5 to 35 eV [6]. From these distributions one can identify processes that are pertinent in creation of neutral atoms. In order to eliminate contribution of atoms produced by dissociation of O_2 inside the mass analyzer, the electron energy range was varied from 13.6 eV (required for direct ionization of O) up to 19 eV (less then O_2 dissociation threshold). Total concentrations of atomic oxygen were obtained by integrating electron energy dependent curves in this range. The results are presented in Fig. 1. for different values of power given by RF source and two feed gas flow rates (2 slm and 3 slm of 99% He and 1% O_2). An increase in concentrations can be seen resulting both from increases of power and unexpectedly the flow rate.

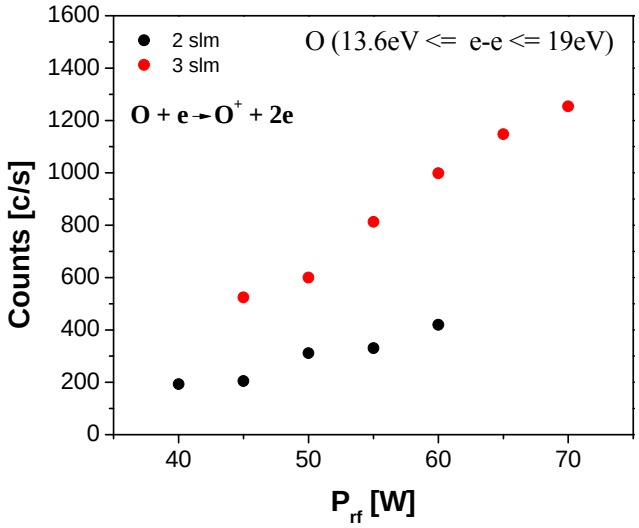

Fig. 1: Number of oxygen atoms as function of power given by RF power supply for two different flow rates of a mixture containing 99% of He and 1% of O_2.

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