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OUTER ELECTRODE MATERIAL INFLUENCE ON OZONE GENERATION IN NEGATIVE CORONA DISCHARGE

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Ozone has many industrial applications. It can be used for increasing the shelf life of products, e.g. by reducing the microbial populations in fruits [1] or rapid decomposition [2]. The simple ozone generator based on point-to-plane corona discharge can be used as a local cooling or oxidising system in microelectronics [3]. For such applications the effectiveness of an ozone generator is crucial. On the other hand the ozone production is in many cases inappropriate and should be suppressed. Typical cases can be indoor air cleaning precipitators or copy machines where increased ozone concentration in air could be harmful for people. This problem is still an up-to-date subject. One of the approaches is to use appropriate wire electrode material such as silver [4]. In such case the ozone production was evidently suppressed in comparison with tungsten electrode in corona reactor. The goal this study was to examine the influence of outer electrode ageing on the ozone production and find out how much time does it need to produce stable amount of ozone.

The reactor in our experiments was composed of cylindrical wire-to-cylinder system of electrodes. Two outer electrodes with the same dimensions were used in the experiment. One was made of stainless steel and the other one of brass. First the outer electrode was cleaned to remove the layer of oxides from its surface. The reactor have been filled by pure oxygen and closed. Then the negative corona discharge was generated in the reactor. The voltage on the electrodes was constantly 5.4 kV. During 1 hour exposition the time dependence of UV light absorption, discharge current and reactor temperature has been observed. The experiment was repeated 5 times in a row without changing or cleaning the electrodes. The experiments have been carried out at atmospheric pressure and ambient temperature. After the set of expositions the brass electrode was found to be covered by greenish layer of oxides. The steel electrode surface did not show any visible changes. The oxidation of the steel electrode had little systematic effect on the ozone concentration. On the other hand in case of brass electrode systematic diminishing of ozone concentration is evident (see Fig. 1.b). Overall ozone concentration was higher in steel electrode. The time dependence of discharge currents (figure not shown) shows that despite of different ozone concentration these are comparable in all the regimes. Despite the fact that input energy was comparable in all the experiments the ozone concentrations were different. Hence we can suggest that the changing properties of electrode surface are responsible for changes in ozone concentration. The heterogeneous decomposition of ozone molecules on the surface of the outer electrode can be expressed as

$$O_3 + \text{wall} \rightarrow O + O_2 \qquad k_1 = ? \qquad (1)$$

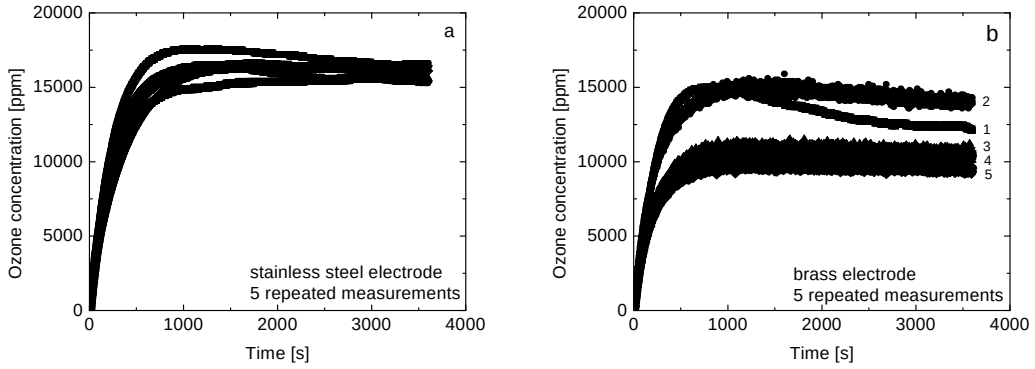

Fig. 1. Time dependence of ozone concentration (a – steel electrode, b – brass electrode).

The rate constant depends on the type of material from which the wall is made and on the dynamics of electric wind transporting ozone molecules through the discharge gap. Simple qualitative analysis shows the differences between various electrode materials. Let ΔN be the number of ozone molecules decomposed on the unit length of the outer electrode per second. This can be calculated if we presume that ozone molecules in thin layer at the outer electrode are transported to the wall by thermal movement. Then $\Delta N = 1/4 \cdot \gamma.n.v_s.2\pi R$, where γ is the probability that ozone molecule is decomposed, n is the concentration of ozone in the discharge gap (we presume for simplicity that there in no gradient in ozone concentration in the discharge gap) and v_s is the mean thermal velocity of ozone molecules determined by temperature. The rate of ozone depletion is then $\frac{dn}{dt} = -\frac{\Delta N}{V} = -\frac{\Delta N}{\pi.R^2} = -\frac{1}{2}\frac{\gamma.v_s}{R}n$. The decrease of the rate of the heterogeneous decomposition is evident. Values of coefficient γ are different even for various types of steel $4x10^{-7}$ – $4x10^{-9}$. For brass it is $0.2x10^{-4}$ [5]. Based on these facts it is possible to suggest that rate constant of process (1) for brass electrode should be higher than for steel electrode. It is in correspondence with experimental results where the ozone concentration was higher in steel electrode.

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