On the possibility of controlling the composition of water by analyzing emissivity spectra from a discharge with an electrolytic cathode

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Abstract. Presents results demonstrating the possibility of using a discharge with a liquid (water) cathode to create miniature analyzers of liquid media.

1. Introduction
As the trend of miniaturization in analytical chemistry instrumentation has progressed, the development of new atmospheric pressure plasma sources has seen increased interest. Currently, there is a need to design spectroanalytical instruments with lower power consumption, reduced sample sizes, compact footprint, low operating costs, and the ability to be operated under ambient conditions [1–3].

If sufficient progress has already been made in the analysis of gas mixtures in this direction [4], the analysis of liquid media still has some difficulties. Note that in the past two decades there has been an increased interest in discharges that are in direct contact with a liquid. Experimental material accumulated on researching the discharge with an electrolyte cathode and / or anode (see for example [5] and reference). It has been established that, in discharges with a liquid cathode, ion bombardment of the latter leads not only to non-equilibrium excitation and dissociation of solvent molecules (water) to form active particles and initiate reactions in the liquid phase, but also to non-equilibrium transfer of solution components in the form of molecules and clusters to the plasma. The transfer products change the composition of the plasma and the set of elementary processes occurring in it. Obviously, this fact can be used in the creation of spectroanalytical instruments for the analysis of liquid media.

In the present paper, preliminary experiments on the investigation of a discharge with a liquid cathode were carried out. As the last used tap water. The electrophysical parameters of the discharge are presented and its possibility to use the analysis of liquid media is shown.

2. Description of the experimental setup and discussion of the results
A nickel rectangular plate was used as the electrode immersed in the liquid, a tungsten rod having a high melting point was used as the metal anode. The vessel was a glass cuvette for a microwave oven, which was used because it has a thick glass, which makes it possible not to be afraid of breakdown.

The distance between the tungsten rod and the surface of the water was adjusted using a micrometer screw. Three variants of the distance between the tungsten anode and the flow ratio were
considered: 1 mm, 3 mm, 10 mm. We used the Ocean Optics 2000 spectrometer to take spectra. Voltage and current were removed using a multimeter with a voltage divider, attenuating the value of 1000 times.

As a result of the experiments, the current-voltage characteristics of discharges with different distances between the liquid cathode and tungsten anode were obtained (see Figure 1).

![Figure 1. Current-voltage characteristics of the discharge with a liquid cathode with different distances of the gas discharge gap.](image)

In figure 2 shows photographs of discharges with a distance between the electrode and water of 3 mm and 10 mm at discharge currents of 20 mA and 80 mA, respectively.

![Figure 2. Photographs of discharges with a distance between the electrode and water of 3 mm (left) and 10 mm (right) at discharge currents of 20 mA and 80 mA, respectively.](image)

Figure 3 shows the spectrum for discharge with the distance between the electrode and the water of 3 mm and the discharge current of 20 mA.

The most intense spectral emission lines of the glow discharge plasma are concentrated in the interval of wavelengths 300 ... 400 nm and correspond mainly to the hydroxyl group OH–, as well as to the single-charged nitrogen ions N+ and oxygen O+, molecular nitrogen and oxygen.

In the visible wavelength range, spectral lines of lithium, copper, potassium, sulfur and aluminum molecules are observed. In the range of 800 ... 1000 nm there are peaks corresponding to calcium and sodium. The excitation efficiency of the spectral lines of different elements is different and depends on both the electrical parameters of the discharge and the design characteristics of the discharge cell and even the temperature of the liquid.
3. Conclusions

Thus, we can conclude that a discharge with a liquid cathode is a convenient tool for creating instruments for analyzing the composition of liquid media. The results indicate that it is possible to conduct a qualitative analysis of the composition of water. At the same time, in order to estimate the quantitative content of elements in a liquid, a preliminary calibration by samples with a known composition is necessary.

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