THE INVESTIGATION OF THE MECHANISM OF ENERGY ACCUMULATION IN LONG-LIVING LIGHTNING OBJECTS, FOUND AFTER A POWERFUL IMPULSE ENERGY RELEASE IN WATER.

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ABSTRACT

The long-living lightning objects (LLO), formed after an electric discharge in water, were reported by the authors recently [1,2]. In the process of researching the spectra of LLO and of the discharge plasma emission, the optical properties of the objects, their dynamics, their interaction with obstacles, the physical fields, and other related phenomena were studied. The whole set of obtained data indicates that the formation of LLO was unknown before our report of this phenomenon. This phenomenon couldn't be explained by such effects as luminescence of the electrode's material, combustion (reactions between hydrogen and oxygen), a cluster of ideal or non-ideal plasma or an association of exited molecules and atoms.

INTRODUCTION

The main difficulty we have is to develop an explanation of the shape and energetics of the objects. LLO, which are formed of the products of discharge plasma, have a shape which is very close to a sphere. The LLO's do not lose this shape under considerable mechanical interactions. The matter comprising the LLO objects has the ability to accumulate energy [from some source] which is spent on emission with power of the order of 0.1 Wt/cm3. In some cases, the LLO's emission is followed by a process, which could be identified as a burst.

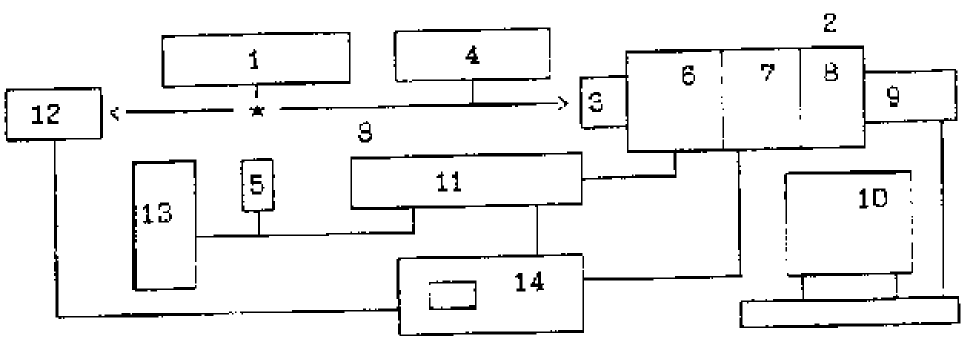

Fig.1
1-generator of high-voltage impulses, 2-EOC, 3-objective, 4-monochromator, 5-device of phasing, 6-time-analysing EOT, 7,8-brightness amplifiers, 9-CCD digital camera, 10-IBM PC/AT, 11-controller, 12-photomultiplier, 13-source of the standard spectrum, 14-oscillograph.

The present work is about the experiments, due to which the data on the formation and energetics of LLO were obtained. A schematic diagram of the experimental device is presented on Fig. 1. The initiation of plasma in water requires a generator to produce high-voltage impulses. This generator was built from the scheme of Arkad'ev-Marx. The breakdown voltage used is about 60 kV, stored energy to produce about 30 Joules. The time of energy release is about 6 microsec. The processes, which follow the discharges, were recorded by using an electron-optical camera (EOC), which was made on the base of time-analyzing electron-optical transducer (EOT) of the PIM-103 type and by using brightness amplifiers PMU-2B and PM-031. The EOC was used in the frame-by-frame mode and also in the chronography mode. In the first case we had an opportunity to use up to 9 frames. An exposition of each frame, including intervals [between frames] could be set independently of one another in 50 ns to 100 mcs [micro-seconds] increments. In the second mode the EOC provides a time-analysis of one-dimension picture (spectra of emission, for example). The time of chronography could be changed from 50 ns to 100 mcs. There was also a feature to delay the start of shooting after the initiating impulse. The minimum time of delay was 30 ns, the maximum was 0.1 s. Amplification of brightness of the EOC image could be changed over a wide region and could reach 10^6 Wt/Wt [sic] on the wavelength of 0.42 mcm, depending on the type of the photocathode used in the time-analyzing EOT.

It was possible to record video-information on film and on the laboratory IBM PC/AT personal computer. In the first case the recording was conducted by using contact with the screen of the brightness-amplifier PMU-28. (PM-031 was not used). Data input to the personal computer was accomplished using "no-film" video-information device. The information was read from the device with a help of cooled CCD matrix. There was a need to connect the solid-body device of no-film record with the EOC. For diminished images from the PM-031, we used this brightness amplifier. The PM-031 used a screen with maximum of emission at wavelength 630 nm. Processing of the video information was accomplished using a package of computer programs, making it possible to scale and to pseudocolor the image received and also helped to measure the relative density of emission at every point of the image and to point out the regions with equal density. When working with recording and analyzing the spectra of this complexity, we were able to automatically partition the time intervals by wavelengths. The wavelengths of lines of emission or absorption were found and real spectral density of emissions from the object were determined (using the comparison with a spectra of a standard source).

Control of the EOC's work was accomplished with the help of dual-beam oscilloscope (C8-14 type.) Signals indicating the functions of the camera were transmitted on one of photo-multiplier channels (thereby registering emission accompanying the studied process).

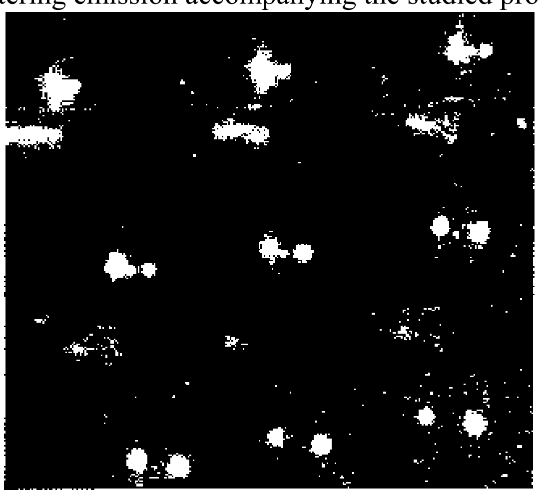

Fig. 2

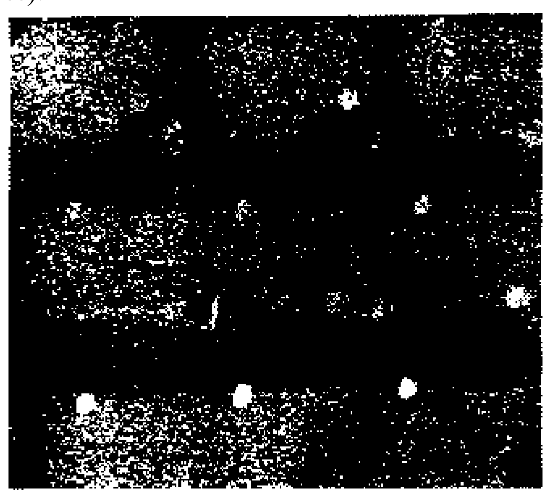

Fig. 3

Fig. 2

Fig. 3

LLO were found for the first time inside a pulsating cavern, formed in water after a powerful energy release [1,2]. Later there was found the way to eject discharge plasma out of the water into the atmosphere [3,4]. Using the same conditions of energy release, LLO discharges into the atmosphere had, on the average, 5 times greater dimensions (up to 0.5 cm) and duration (time of luminescence) of up to 0.1 s. Fig. 2 presents the results of frame-by-frame recording of the process of LLO formation out of an irregular luminescent cloud. This cloud was ejected to the atmosphere after the discharge in water (the recording was done using the illumination of the LLO). The plasma was ejected upwards out of the water. The time lag from the start of recording to the end of the energy release was 500 mcs. The time of exposure was 10mcs, and the interval between two frames was 10^{-4} s. The order of frames was from left to right, from top to bottom. The maximum dimensions of an LLO was approximately 3 mm. One can see on the image that two LLO are gradually forming from the cloud (one big and one small cluster - see images 5 and 6). The smaller cluster disappears quickly, however the larger cluster exists until the end of the recording sequence.

On the first frame one can already see a formed LLO, which expands later, reaching its maximum on frame 6 together with the cloud [as the cloud appears to reach its maximum brightness. The densitometry of the negative shows the density of the radiation flux from the LLO, which was formed from this cloud. The process which was registered on Fig. 2 resembles condensation. The formation of the LLO was found also at a time when there was an influence of low temperature on the ejected products. In this experiment a copper plate, cooled to the boiling point of liquid nitrogen, was placed in the way of ejected plasma flying out of the field the camera. It was found, that the already formed LLO clusters disappear on their way to this cooled surface. That is, the LLOs cease to shine. On the other hand, there were found some cases of shining objects forming on this cooled surface. These surfaces objects were evidently formed from the products of discharge, which had traveled to the surface. The dynamics of such a process is presented in Fig.3. Shooting was delayed for 1 ms. The speed of recording was the same as before. The side light was positioned and used for determination of the location on the cooled surface and of the jet position with respect to the camera, thus showing the space between them. On each frame of Fig. 3, this space is seen as a poorly shining square, the "jet" is coming out of the camera from below. Products of disintegration are moving up from the bottom. A start of formation of an LLO object [on the chilled plate] is seen in frame 3 (Fig. 3, upper right) as a slight nonuniformity in the upper left portion of frame 3. Fig. 3 shows on frames 4, 5, 6, & 7 the increase in brightness of this object. On frame 7 one sees a well-formed LLO. The same processes were observed under the illumination of the objects own light (without the use of the side-light).

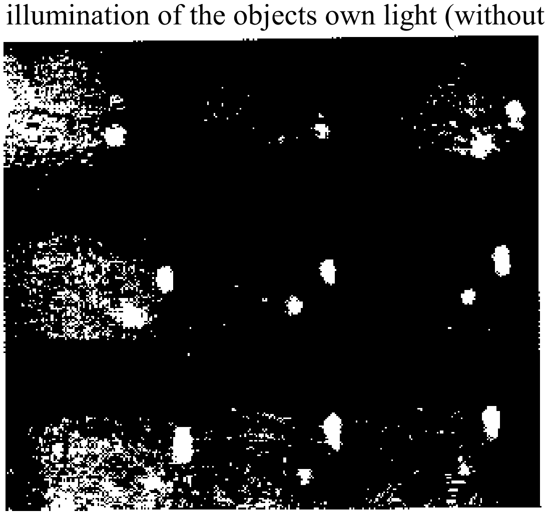

Fig. 4

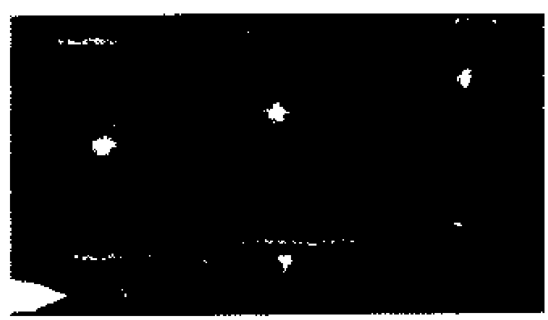

Fig. 5

Fig. 4

Fig. 5

Another interesting case of low temperatures influence on LLO is presented in Fig. 4. The delay of recording was 500 mcs, and the frame interval of recording the same. On this image the elongation of the LLO's toward the side of the cooled surface can be observed. The analysis of the photograph shows that this elongation is connected with building-up of the LLO's shining matter from the low temperature side. The rate of growth is comparable to the speed of movement of the objects (of the order of 10 m/s). On the photograph one can see another LLO, which grows and diminishes during the recording of Fig. 4.

The influence of high temperatures on these shining objects is shown in Fig.5. The recording was made using the emitted light from the "shining objects." The speed of recording and the order of the frames was the same. The number of frames was 6. In this experiment a plane two-fold metal spiral was used instead of the cooled surface. The metal spiral was heated by an electric current. The diameter of the Ni/Cr alloy wire was 0.1 mm, with the step of winding = 1 mm. The temperature of heated wire mesh was measured using a pyrometer and equaled 1000°K for the upper layer and 800°K for the lower layer. The distance between layers was 4 mm. The LLOs could freely pass through both layers of wire. Some filters were during the recording. These filters were used to block out an intense infra-red emission from the two wires. The upper layer of the spiral is seen on each frame (Fig. 5). The lower wire is indicated on Fig. 5 with an arrow. One can clearly see that LLO lose their spherical shape when they come up to the zone of heating. They disappear completely near the lower layer of the spiral. Any darkening in this case is out of question. In the space between two layers the LLO appears once more. They disappear again when they cross the second layer. The LLO's disappearance is observed at a time of its crossing the heated spiral in 40% of the cases observed. Sometimes the shining objects appear once more, though they are much smaller in dimensions.

All these observations emphasize the dependence of the processes of LLO luminescence on the temperature and on the presence of a strong interparticle interaction within the LLO's matter. This interaction can modify some processes, which are analogous to phase transitions accompanied by heating. This heating may explain LLO's luminescence at a time of its formation on cooled surface. Temperature is sustained by heating, which is a result of condensation.

In [1,2] the authors propose a cluster nature for the LLO. Still, all these experiments shown above contradict this hypothesis. All parameters of charged water clusters are known [5]. At the time of their heating up to 1000°K the covers of the LLOs must destruct, thus causing a sharp growth in the speed of recombination and, as a consequence, the rapid release of energy. In all of the experiments using heating, there were no phenomena which were considered to be the result of this process (flash of light, ejection of the substance, and so on). The explanation of the nature of the LLO's is difficult using the concept of clusters of non-ideal plasma. This plasma, having appeared at discharge, could not disintegrate and condense once more, because all properties of the non-ideal plasma are explained by collective interaction of charged particles. All the more reason that one cannot explain the formation of a clot of non-ideal plasma on a cooled surface by the condensation on this surface by products of disintegration and just recombined discharge plasma. In addition, one can hardly explain the fact of LLO's penetration from the cavity to water [1,2] and the fact that the LLOs maintain their spherical form even when their speed in air is higher than 50 m/s (using a model of non-ideal or cluster plasma.)

CONCLUSION

All the foregoing enables the authors to put forward the hypothesis that LLO's matter consists of previously unknown combination of oxygen and hydrogen, which has a store of energy that exceeds thermodynamic equilibrium energy. This hypothesis is confirmed by the results of spectral investigation. After 20 mcs after the end of energy release there was found, in the spectrum of emission of disintegrating water plasma, registered a group of lines lying in wavebands: 792-798 nm, and 741-744 nm. This group of lines is observed for a period of 100 mcs and cannot be identified as spectral lines of hydrogen, oxygen, water or the OH-group. The formation of these lines always preceded the formation of LLO.

The fact that these are not associated with hydrogen, oxygen, or water unequivocally supports the author's conclusions.

A meta-stable combination having a store of energy can appear from the stage of disintegration of plasma from exited atoms or molecules. Much more probable is the formation of combinations with meta-stable atoms because of their long lifetimes. In addition to the above-mentioned group of lines, there were found lines of emission of hydrogen and oxygen in the emission spectrum of the disintegrating plasma. These lines appear 5 mcs after the end of the observed energy release and are registered for about 5-10 mcs. One of this group of lines with wavelengths: 7771,94; 7774,39 Å [6] is an evidence of meta-stable atoms of oxygen formations on this stage. These atoms are in a 3S state and their line of emission is 180 mcs [7]. It is quite logical to suppose that meta-stable atoms of hydrogen are also formed under these conditions. They are in the 2S-state and have a duration of 10^{-1} sec. The upper electron levels of these exited atoms are similar to the valence levels of atoms of alkali metals. That is why there are some reactions between these exited atoms of oxygen, hydrogen and molecules of water. These reactions are like those which happen in certain types of lasers [8] between exited atoms of inert gases and halogen gases.

Such excited complexes can have energy of the order of a few electron-volts. Their duration could be long enough. For example, this could happen because of a potential barrier, which hampers the rebuilding of electron layers of excited complexes into electron layers of stable excited molecules. Each such complex, by our estimate, has a store of energy, which considerably (more than 10 times) exceeds the energy released by a chemical reaction.

It is perfectly clear that matter, consisting of such high-energy complexes, is an example of an ecologically clean fuel, because the final products after its use are nothing but ordinary water. In addition, one can state (with a large probability of being correct) that such a substance (i.e. an previously unknown high-energy combination based on O and H) is highly effective and, in general, a different natural phenomena. This phenomena is accompanied by a powerful energy release from any origin in water-saturated structures (including Earth's crust, atmosphere, ocean and so on). One such manifestations is the phenomenon of ball lightning and long-living lightning objects in the atmosphere. The interest is such phenomena has grown sharply recently. To prove this statement we must remind the reader of a number of international scientific conferences and symposiums on the above-mentioned problems that have been held (e.g. in Japan, Hungary, USA, Austria) in 1988-1993.

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