SONOLUMINESCENCE OF WATER AND BIOLOGICAL LIQUIDS

VLADIMIR CHERNOV, DMITRY SELIVANOVSKY

Institute of Applied Physics, RAS
46 Ulyanov Str., Nizhny Novgorod 603950, Russia
cher@hale.appl.sci-nnov.ru

In this work the results of experimental research of the sonoluminescence of water and biological liquid (plasma of blood) at different temperatures are described. The studied blood plasma was taken from normal and pathological patients. Sonoluminescence of water was found to decrease with a decrease in temperature. Samples of normal blood plasma produce sonoluminescence with approximately constant intensity at cooling. In contrast, sonoluminescence of pathological blood plasma increases with decreasing temperature. These results can be useful for investigations of the nature of sonoluminescence as well as for medical diagnostics.

INTRODUCTION

The phenomenon of sonoluminescence has been known for many decades but its mechanism is still unclear. Nevertheless, as was found in the recent years by a group of scientists from Nizhny Novgorod, this effect can be used in some practical applications. It was demonstrated, for example, that parameters of sonoluminescence of some biological substances such as blood plasma can be successfully employed for medical diagnostics [1-3].

1. EXPERIMENTS

Sonoluminescence (SL) of liquids was measured at constant intensity of ultrasound at different driving frequencies: 350 kHz, 530 kHz, and 780 kHz. The electrical power in experiments did not exceed 10 W. The luminescence was registered at wavelengths ranging from 300 nm to 700 nm. A sample of blood plasma did not exceed 1.5 ml. The conditions of measurements were kept constant. Samples of blood were taken from patients veins. The schematic of the experiments is shown in Fig. 1, where 1 is a generator, 2 is a metal box with

piezoceramic transducer at the bottom and the studied liquid on top, 3 is a photomultiplier, and 4 is an indicator (counter of photons).

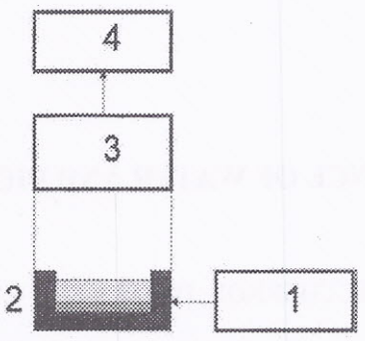

Fig. 1. The schematic of measurements.

2. RESULTS OF EXPERIMENTS

SL measurements from more than 8000 patients having diseases such as cancer, AIDS, tuberculosis, etc. have shown that a change of SL intensity in time differs for different samples taken from patients with the specified diseases and for healthy people [1-3]. Typical dependences of SL intensity on time for normal blood plasma and for blood plasma with diseases are plotted in Fig. 2.

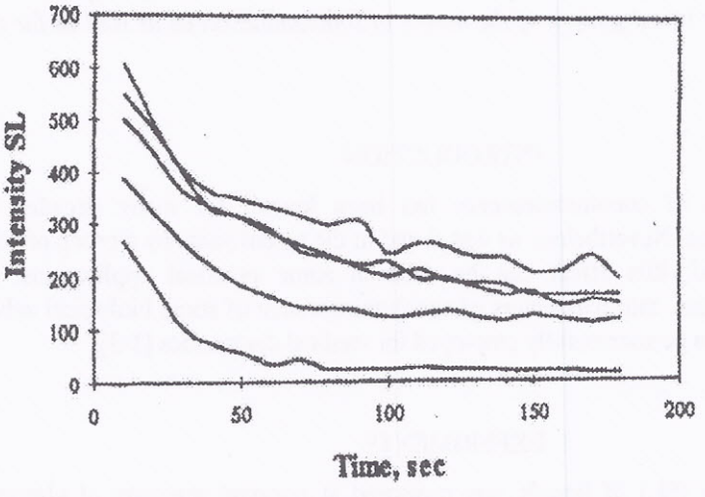

Fig. 2. Some typical dependences of SL intensity on time for 3 cases of normal blood plasma (the upper curves) and the case of cancer blood plasma (the lower curve); the second curve from the bottom is for patients with AIDS.

The intensity of luminescence was higher for the group of healthy people. The lowest level of SL was registered for patients with cancer. For tubercular patients parameters of sonoluminescence of blood plasma were investigated for 465 patients, including 395 patients with pathology and 70 healthy people (control group) [4]. The goal of this investigation was to develop methods for differential diagnosis and for testing activity of tubercular process. The normalized integral index of sonoluminescence K was suggested (the summarized amount of SL impulses from blood plasma during measurements divided by the amount of SL impulses from distilled water).

For differential diagnosis the index K of sonoluminescence was determined by measurements from 347 pulmanological patients, including 171 patients with tuberculosis, 107 with sarcoidosis, and 69 with cancer of lungs. The control group consisted of 70 healthy students. The integral index of sonoluminescence of blood plasma was found to be an infomative diagnostic parameter for 91 % of the tuberculosis patients, for 87% of the sarcoidosis patients, and for 85 % of patients with cancer of lungs. Figure 3 shows the distribution of the SL index for the different diseases.

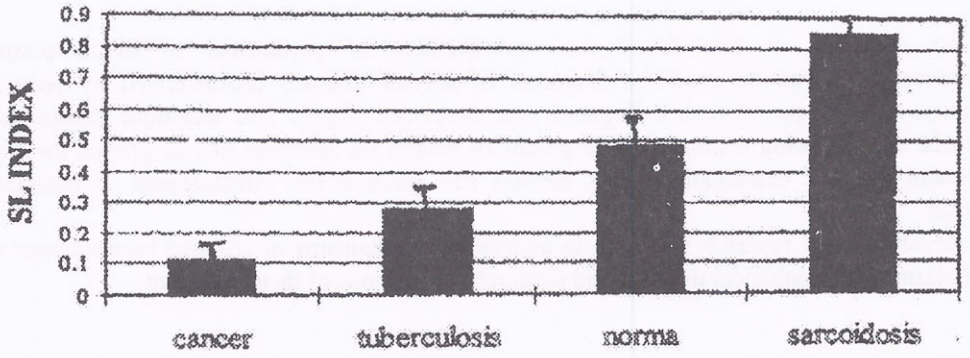

Fig. 3. Distribution of the SL index.

Study of sonoluminescence of blood plasma aiming at testing activity of tubercular process was carried out for 58 children, 30 of whom had active tuberculosis of respiratory organs, 7 posttubercular modifications, 11 had no tubercular diseases, and 10 were healthy children (control group). The index K was found to systematically differ for 72-80 % of the children of those 4 groups. For 82% of children with active tuberculosis of respiratory organs treatment caused the increase in the index K up to values characteristic of healthy children.

Experimental research shows that sonoluminescence of water and plasma of blood reduces at cooling as a rule. It was revealed, however, that in some samples of blood plasma that has no luminescence at room temperature the level of sonoluminescence increases at cooling.

The discovered effect of an increase of the level of sonoluminescence of biological liquid at cooling was unknown before. Earlier it was supposed that the sonoluminescence of blood plasma in the course of ultrasound action drops down to values close to the level of dark noise current. However, our experiments verified that cooling of some samples of blood plasma of oncological patients down to temperatures close to freezing increases the intensity of sonoluminescence.

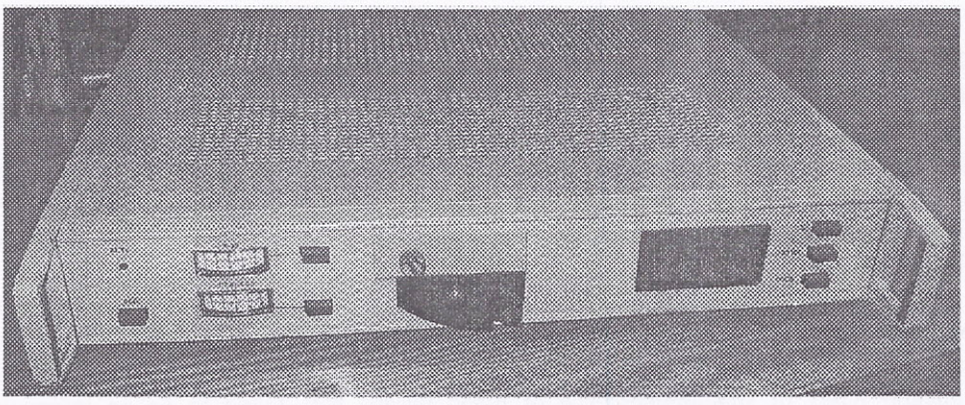

Fig.4. The Image of diagnostic sonoluminescence device.

3. CONCLUSION

To conclude, it was found that measurement of parameters of blood plasma sonoluminescence can be used for diagnosis of several diseases characterized by reduced immunity. A technique of such a diagnosis was developed (fig.4). This technique ensures fast diagnosis, thus allowing testing of large groups of people for selection of risk groups for their subsequent detailed examination. This method can increase the effectiveness of insurance medicine.

Results of this research will help to understand mechanisms of reduced luminescence of blood plasma for oncological diseases and to search for methods of their treatment.

ACKNOWLEDGEMENT

This work was supported by RFBR (01-02-17411).

REFERENCES

1. V.V. Chernov, S.M. Gorsky, I.D. Karev, I.G. Terent'ev. "Ultrasonic luminescence of blood plasma and diagnostic of cancer." Acoustical Journal, V.35, N2, p.364, 1989.
2. V.V. Chernov, R.F. Mishanov, V.Z. Zhadnov. "The sonoluminescence of blood in differential diagnostics of a tuberculosis, cancer and sarcoidosis". Problems of a Tuberculosis, V.6, pp.42-43, 1994.
3. V.V. Chernov, A.V. Efimov, V.Z. Zhadnov, R.F. Mishanov. "The sonoluminescence of a blood plasma". Nonlinear Acoustics in Perspective, Proceedings of the 14-th International Symposium on Nonlinear Acoustics, China, Nanjing, pp.219-223, 1996.
4. V. Chernov, V.Z. Zhadnov, R.F. Mishanov, I.A. Shirokova. "The application of sono-luminescence in medical diagnostics". Abstracts of the 16th International Symposium on Nonlinear Acoustics, August 19-23, 2002. Moscow State University, Moscow, Russia, p.142, 2002.