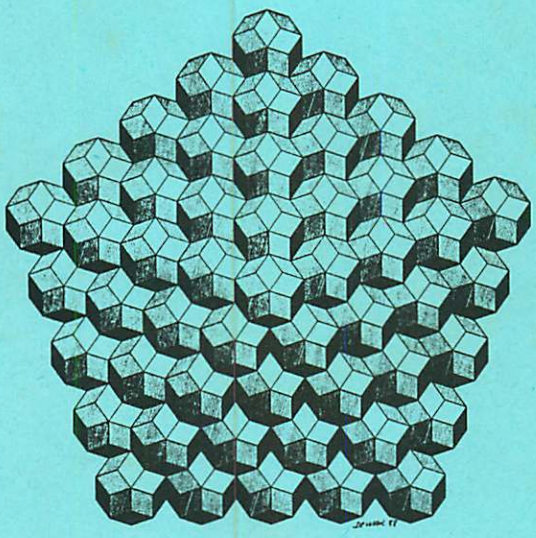
Symmetry of STRUCTURE

an interdisciplinary Symposium

Abstracts

I.



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BROKEN SYMMETRY OF STRUCTURE OF GAS-DISCHARGE LICHTENBERG FIGURE WHEN BYOLOGICAL LIQUID IS PLACED INTO ELECTRIC FIELD

G.Z.Gudakova, I.E.Lublinskaya
Departement of physics, Lensoveta Technological institute
Moskovsky prosp. 26, Leningrad, I98013. U.S.S.R.

The method of gas-discharge vizualization (GDV) which allows to receive the information about surface and volume properties of objects is well-known [I].

The essence of the method lies in the study of low-current gas-discharge, which develops near the surface of investigated object under the influence of high electric field ($E=10^5-10^6$ V/sm). The sliding gas discharge, which develops in the electrode system "spike-plane" is more suitable for the study of byological liquids[2]. This kind of gas-discharge leads to the formation of gas-discharge images (GDI) known as Lichtenberg figures. GDI represents the traces of ionization channels (strymmers) registrated on the photometerial. In general the length and branchihg extent of channels depend on the magnitude,shape and polarity of tension, configuration and structure of electrodes and also on gas properties such as composition, pressure, temperature etc.

If one of electrodes is the radial symmetry metall spike, Lichtenberg figure looks like halo with its shape, close to the circle and the uniform distribution of branches (Fig.I).

When byological liquid stands for the spike discharge figure looks like halo with non-uniform density of spoiling. Halo shape and dimension change depending on the phvsiological state of byological liquid (Fig.2). In the last case the parameters of external medium such as gas composition, humidity, temperatnre and properties of tension source being constant. The yeast crop of Candida kind was chosen as a model of byological liquid.

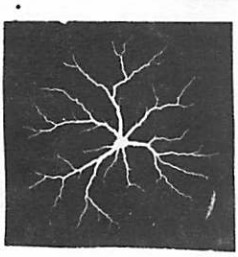
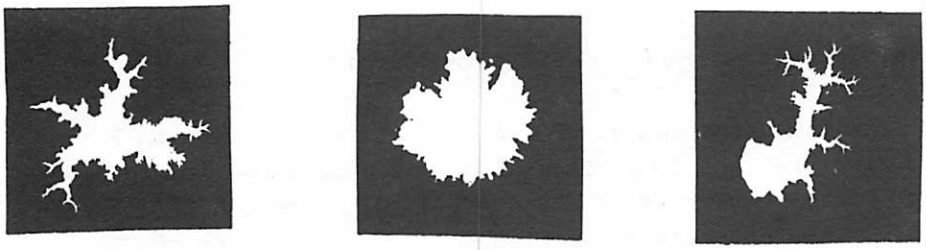


Fig.I. Lichtenberg figure for the radial symmetry metall spike.

Fig.2. Gas-discharge images for Candida yeast crop depending on time of cultivation a-t=24h., b-t=48h., c-t=72h.



a b c

The state dynamics of microorganisms during their development is described by the rise curve M(t) (the dependence of byomass increase on the time of cultivation) and by time-dependence of specific velocity of byomass increase $\mu(t)=\frac{I}{M(t)}\frac{dM}{dt}$ (Fig.3).

Developing in the periodical regime of cultivation the yeast crop passes a number of physiological states (rise phases) which are distinguished both by the presence of metabolits and ferments and by the velocity of byomass increase.

During the cultivation samples of yeast suspension were taken for the invfstigation after each I2 hours [3]. The magnitude byomass, the level of gas-exchange and pH were defined independently. A number of geometrical parameters which describe the broken symmetry of Lichtenberg figure was used for the quantitative estimation of the gas-discharge images. This broken symmetry becomes apparent in the deviation of the GDI shape from the circle and in the deviation of distribution of channels of ionization from the uniform one [4]. Such parameters as shape coefficient $K=\frac{p^2}{4\pi s}$, where p- the out-line perimeter of halo, s- halo area, N- number of discharge branches outgoing from the center of spoilihg spot, d- diameter of spoiling spot are belong to the mentioned parameters.

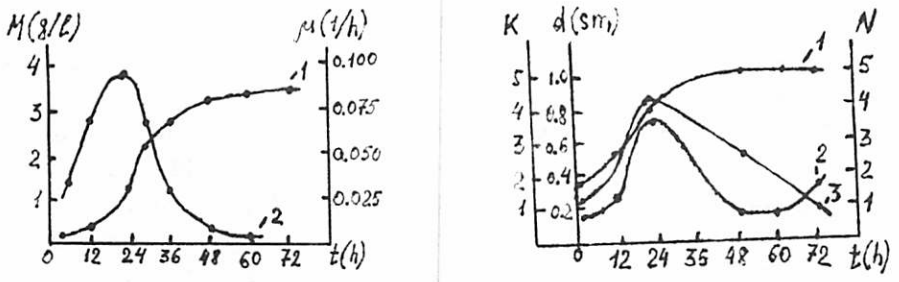


Fig.3.Rise curve of byomass (I) and time-dependence of the spe-

cific velocity of byomass increase (2).

Fig.4. Time-dependences of GDI parameters:
I- d, 2- K, 3- N.

The time-dependences of GDI parameters are shown in Fig.4. It's seen from the comparison of dependences shown in Fig.3,4 that change regularity of K and μ, d and M coincide correspondently. This coincidence enables to use the totality of GDI parameters for the diagnostics of the physiological state of byological liquid.

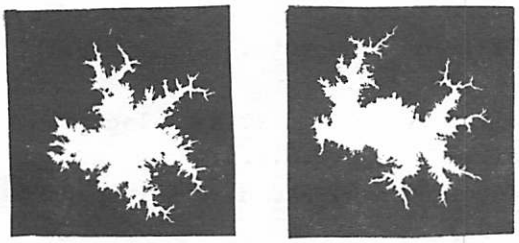
The comparison of GDI appearance (Fig.2) with the mentioned curves (Fig.3,4) shows that the most characteristic phases in the development of crop (24,48,72 hours of cultivation) are distinguished by both GDI appearance and parameters tendency of change. In the phase of more active physiological state when specific velocity of byomass increase takes its greatest value, the asymmetry extent of GDI shape is also the greatest, and it corresponds to the maximum value of K. The number of discharge branches N also takes its maximum value and their distribution on the area of GDI is even (Fig.2,a). In the phase of steady equilibrium, which means the vital activity stopping of microorganisms (μ=0) GDI shape has a symmetry appearance, its out-line closes to the circle and internal ctructure is partially obligerated (Fig.2,b). The shape coefficient K takes its minimum value (K= =I) and diameter of central spot is in maximum. The phase of eventual states of yeast crop is characterized by partial or full destruction of cells. In this case shape asymmetry of GDI as a rule connects with existing of one discharge branche outgoing from the central spot (Fig.2,c). GDI parameter K increases a little but its value significantly smaller than in a maximum. Spot diameter doesn't change practically.

Human blood was chosen in the capasity of another byological liquid for the investigation. It is considered to be one of the most sensitive organism medium and it is a good indicator of organism state.

Additional to the described parameter was introduced for the estimation of the state of man in accordance with GDI appearance. It defines the prolation of the GDI shape ξ=L/l, where L and l represent the lengths of maximum and minimum mutually perpendicular chords passing through the central spot of spoiling.

Blood samples of patients were taken during the first three days after their entering into the department of infarction re-

animation. It's seen from the Fig.5 that GDI of the blood of healthy (donor) and of patient being in condition of acute pathology differ considerably in asymmetry extent of shape and structure.



a b

Fig.5. Gas-discharge images of donor's blood (a) and infarctional patient (b).

The values of GDI parameters of the donor's blood were taken as standard ones (see the Ist line in table).

The more the deviation of the values of GDI parameters of the patient blood taken in total from the standard ones, the more serious cmplications accompany the illness.

During the investigation by blind way three characteristic group of patients were revwaled in accordance with the extent of heaviness of their illnesses (table):

number group	shape coefficient K	spot diameter d, sm	branche's number N	shape prolation ζ	prediction of illness's flow
donor	3.4±0.5	0.20±0.05	5.2±0.5	I.2±0.2	
I	2.2±0.4	0.66±0.08	3.9±0.4	I.2±0.2	without complications
2	I.8±0.4	I.I±0.2	2.I±0.5	I.4±0.I	without fatal complications
3	I.3±0.I	0.72±0.08	I.2±0.2	I.9±0.I	with fatal complications

The results of the prediction of the acute infarction miocardus flow which are received with the help of GDV method for a period of IO days after the investigation and confirmed during medical inspection of patients are presented in last column of the table.

Thus, the choice of the more informational GDI parameters on the base of the shape and structure symmetry enables reliably to distinguish the physiological state of byological liquids of any nature.

I. Kirlian S.D., Kirlian V.H. (I96I). 2. Gudakova G.Z., Kukuj L.M., Ganelina I.E. (I988). 3. Gudakova G.Z,, Galinkin V.A., Korotkov K. G. (I988).

BIBLIOGRAPHY

Astrov J.A. et al. JTP. I978. V.48.P.393. (U.S.S.R.).
Banjkovsky N.G., Korotkov K.G. Pisjma v JTP. I982. V.8.P.2I6 (USSR
Boxier C., Pulson H. J.Biol.Photogr.Assoc. I979. V.45.P.5I.
Galinkin V.A., Gudakova G.Z. LTI imeni Lensoveta. Dep. v VINITI. I985. N 4325-85. (U.S.S.R.).
Gudakova G.Z., Kukuj L.M., Ganelina I.E. Diagnostika i lechenie infarkta miocarda. Conf. Tbilisi.I987. (U.S.S.R.).
Gudakova G.Z., Galinkin V.A., Korotkov K.G. Journ. prikl.spectroskop. I988. V.49.P.4I2. (U.S.S.R.).
Gudakova G.Z., Galinkin V.A., Korotkov K.G. Mikologia i phitopatologia. I989. (be published).
Kirlian S.D., Kirlian V.H. Journ. nauch.prikl.photogr. i kinematography. I96I. V.6.P.39I. (U.S.S.R.).
Kojarinov V.V. et al. Electro-discharge method of vizualization. I986. (U.S.S.R.).
Konikevich E.W. J.Biol.Photogr.Assoc. I977. V.45.P.II5.
Lublinskaya I.E., Gudakova G.Z. LTI imeni Lensoveta. Dep. v VINITI. I989. (be published).