EFFECT OF TEMPERATURE ON THE NANOCLUSTER STRUCTURES IN A CONCENTRATED OF AQUEOUS SOLUTIONS OF GLUCOSE

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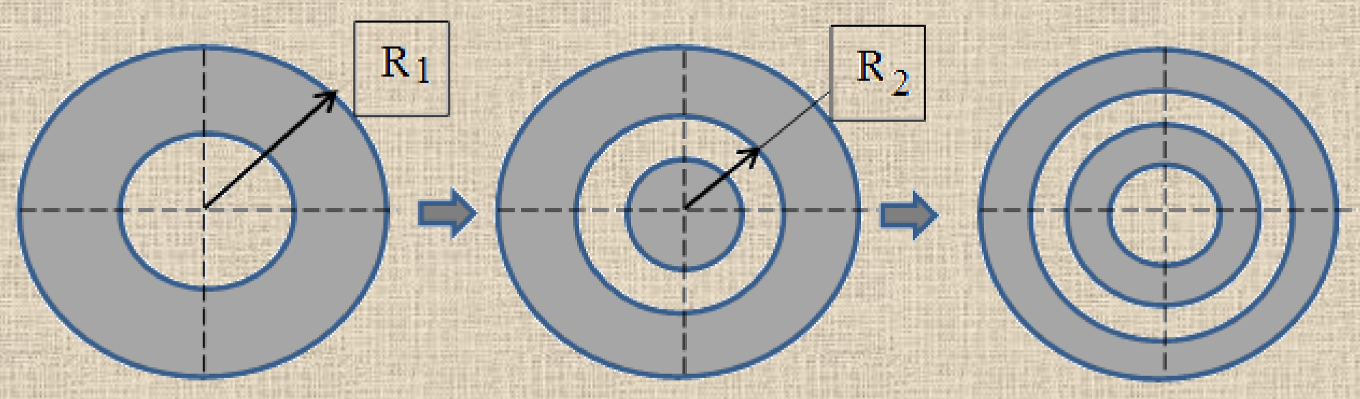
Introduction

A thermodynamic model of the solution is proposed. According to this model the solution is considered as a set of nanocrystals of glucose crystal hydrate surrounded by a liquid phase. With the use of proposed model, it is shown that at temperatures near the temperature of the phase transition between the mentioned phases, the solution is in a significantly non-equilibrium state, forming a dissipative space-time structure, which is a collection of autowaves [1]. Nanocrystals are considered as a source of autowaves. The fact of the existence of autowaves was confirmed by an experiment on the scattering of light by a 40% aqueous solution of glucose in the temperature range of 20-70°C.

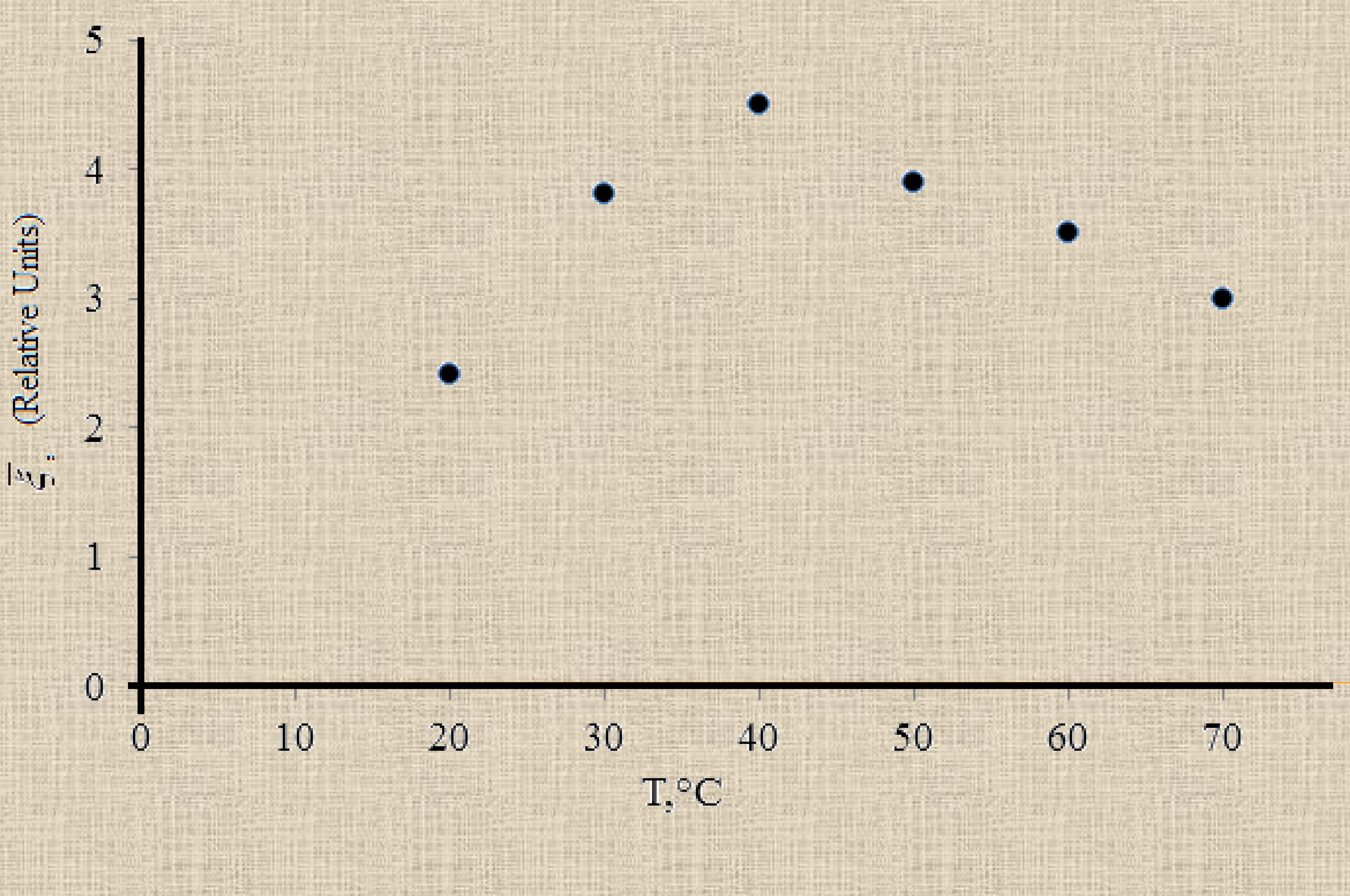
Successive stages of the formation of autowaves in an aqueous solution of glucose:

R_1-radius of the matrix (liquid A-phase), where the condition is fulfilled $T_A(r = R_1) = T_1$ (r-radius-vector of the point of the space occupied by the system); R_2-radius of the region in the process of phase transition A→B (crystalline phase), where the state of incomplete equilibrium is realized.



The formation of an area whith the state of incomplete equilibrium between phases A and B is realized	The formation and growth of the new area of phase A	Formation of a new region with the state of incomplete equilibrium

Temperature dependence of the average relative intensity of light scattering in a glucose solution with a concentration of 40%



Autowaves and light - scattering

Using the time scale with the parameter τ (the time of establishment of thermodynamic equilibrium in the system), the occurrence of autowaves can be considered as the occurrence of a time dependence of a random field of concentrations $C(\bar{r},t)$

The mathematical expectation and the centered variance (root mean square fluctuation) of a random variable at a moment in time *t* are determined by the relations

$$\langle \varepsilon(t) \rangle = \frac{1}{V}\int_V \varepsilon(\bar{r},t)d\bar{r} \qquad (1) \qquad \langle \Delta\varepsilon^2(t) \rangle = \frac{1}{V}\int_V [\varepsilon(\bar{r},t) - \bar{\varepsilon}(t)]^2 d\bar{r} \qquad (2)$$

where *V* is the volume of the system.

As is known (see, e.g., [2], etc.), for the intensity of scattered light in liquid systems the relation

$$I \backsim \langle \Delta\varepsilon^2 \rangle. \qquad (3)$$

From the comparison of relations (1) and (2), it follows that when choosing a time scale with a parameter τ, the intensity is a random function of time. Accordingly, observing the behavior over time, we get one of the possible implementations of this function.

Conclusions

A concentrated aqueous solution of glucose in the temperature range near the temperature of the transition to the high-temperature phase, is in a strongly unbalanced state. In this state a dissipative space-time structure with of autowaves-processes is formed. The area with auto-oscillations passes alternately from a low-temperature (crystalline) phase to a high-temperature (liquid) phase.

During the growth of a nanocrystal, heat is released, which causes the appearance of a liquid phase region inside the crystal.Its size increases simultaneously with the growth of the nanocrystal.

The absorption of heat accompanying the increase in the size of the liquid phase area leads to the emergence of a new section of the crystalline phase within this area. The mentioned processes are continuously repeated. The area with nanocrystal becomes the center from which the spherical layers of the liquid and crystalline phases alternately move away, forming a spherical autowave.

Rererences

1. **L. A. Bulavin, Yu .F. Zabashta, M. M. Lazarenko, L. Yu. Vergun, K. O. Ogorodnik, K.I. Hnatiuk.** Autowaves Induced by First-Order Phase Transitions. Ukr. J. Phys. 2022. Vol. 67, No. 4.p.270-276.

2. **I.I.Adamenko, L.A.Bulavin.** Physics of Liquid and Liquid Systems, “ACMI”, Kyiv,2006 (in Ukranian)