Slovak Physical Society

24th CONFERENCE OF SLOVAK PHYSICISTS

2. - 5. 9. 2019
University of Žilina, Žilina

PROCEEDINGS

Editors: A. Džubinská, M. Reiffers

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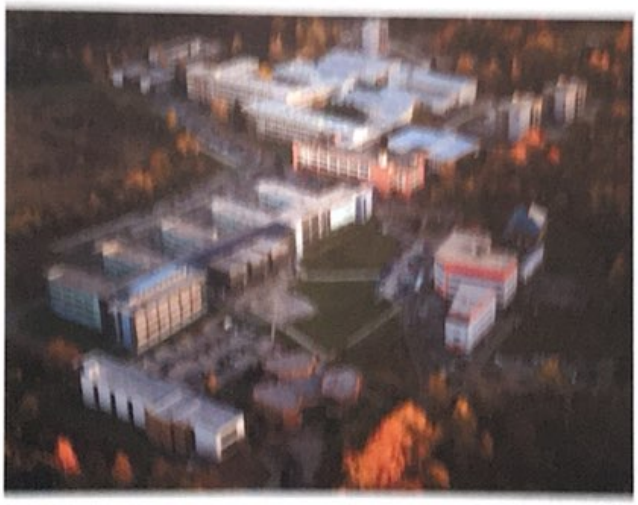

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Editors: Ing. RNDr. Andrea Džubinská, prof. RNDr. Marián Reiffers

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OPENING ADDRESS

Ladies and Gentlemen,

The Conferences of the Slovak Physicists are organized by the Slovak Physical Society. By organising the 24th Conference we continue in the tradition to visit successively institutions and places, which are important from the viewpoint of physics research and physics teaching. This time it was the University of Žilina. Its rich tradition occupies an important place among Slovak universities, not only by the number of students, by offering interesting and quality study programs, but also by significant research and foreign activities. I would like to thank the members of organising committee for their efforts which resulted in a well-organised conference.

The Conferences of the Slovak Physicists have a long tradition. They are held annually. The participants of these general conferences are scientists and teachers from the universities, institutes of the Slovak Academy of Sciences and other institutions, working in the field of basic or applied research. Among participants there are also teachers from secondary schools and young post-graduate physicists. The programme and organising committees hope that this year they invited plenary lecturers with interesting and timely topics of a high scientific level. I would like to mention also interesting short talks and the presentations of the laureates of the Competition of Scientific Works of Young Physicists. The Conferences of the Slovak Physicists have been providing a unique opportunity for all physicists, teachers and PhD. students to present their research and educational work and results.

In conclusion, I would like to thank my colleagues from the Slovak Physical Society, the members of the Organising and Programme Committees, as well as other colleagues, who contributed to the organization of this conference. I would like to thank you, the participants of this Conference, mainly for your active attendance and valuable contributions. I think that the 24th Conference of the Slovak Physicists had a high scientific level. It was a successful event which contributed to the further development of physics in Slovakia. I hope that you all spent useful as well as pleasant time in Žilina.

Július Cirák
President of the Slovak Physical Society

CONTENT

SELF-ORGANIZED STRUCTURES AND FRACTALITY OF THE NON-CRYSTALLINE MATERIALS As(Ge)-S(Se) SYSTEMS

M. Mar'yan, mykhaylo.maryan@uzhnu.edu.ua, Uzhhorod National University, Ukraine
N. Yurkovych, nataliya.yurkovych@uzhnu.edu.ua, Uzhhorod National University, Ukraine
V. Seben, vladimir.seben@unipo.sk, University of Presov, Slovakia

INTRODUCTION

Synergetics in the present stage is an innovative means of solving applied scientific and technical problems, has an important usage in the obtaining intellectual materials [1, 2]. The implementation of object-oriented modeling also opens up many opportunities for using modern technologies in scientific activities for the realization of interdisciplinary synergetic connections, the development of a model, its amplification by means of informational technology, conducting relevant calculations and analysis of results [2, 3]. This approach will be demonstrated and applied in this paper, using an example of a study of fractality and processes of structuring non-crystalline materials As(Ge)-S(Se) systems.

THE CONCEPTS AND INVESTIGATION METHODS

The peculiarities of structure, properties of non-crystalline solids, their interrelation with methods of obtaining are analyzed. Existing model approaches to describing the structure of non-crystalline solids and the transition to a non-crystalline state consider either individual characteristic time scales of their formation, or a separate group of properties and features of the structure. With significant deviations of the system from equilibrium and in external fields more than critical, synergetic effects and the mechanism of transformation of energy and information play a decisive role [2,3]. The integrity of the formation of a non-crystalline state can be taken into account with the use of a synergetic approach within the framework of the theory of self-organized structures [4], which makes it possible to determine the mode of formation in conjunction with the conditions of obtaining and to predict the possibility of using information technologies (Fig. 1).

Model ideas are presented on the formation of the self-organized structure of non-crystalline solids as a method of self-organization of the system, which is carried out in accordance with the technological conditions of obtaining and under the influence of external fields. Above the point of loss of stability of a thermodynamically equilibrium state is shown the existence of cooling velocities q above the limiting velocity q_c of a self-organized structure. It is established that in a system which, when $q < q_c$ it was uniformly stable, with a cooling rate $q \geq q_c$ spontaneously generates own scale of ordering L_c.

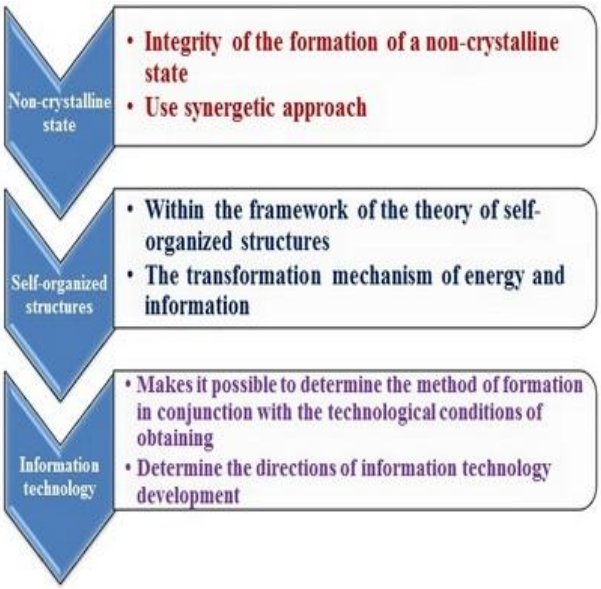

Fig. 1. Integrity of the formation of a non-crystalline state

The dependence of the lifetime τ_{life} and the period of self-organized structures L_c on the cooling velocity are studied. In particular, for non-crystalline materials systems $As-S(Se)$ with characteristic values

$q_c = 5 \cdot 10^{-3} K/s$, $q = (1.5 \cdot 10^{-2} \div 1) K/s$

period

$L_c \approx (10 \div 10^2)$ Å

and correlates with the micro-, nanosized of the middle order [2]. The synergetic approach analyzes the common features of the transition to non-crystalline state for chalcogenide, oxide, metallic, and organic glasses, namely the presence of self-organizing processes and the formation of self-organized structures.

SELF-ORGANIZED STRUCTURES IN THE NON-CRYSTALLINE SOLIDS

The nature of the bifurcation process of transition to a non-crystalline state in the framework of the theory of neural networks with Hebb and Kohenen algorithms is revealed. Considerable attention is paid to the study of self-organizing models that model themselves, the algorithmic complexity of the self-

organized structure. It is shown that the processes of self-organization in non-crystalline materials in the transition to a non-crystalline state, as well as self-consistent allocation through the processes of self-organizing order parameters, can be investigated using the theory of neural networks with back propagation algorithms, Hebb and Kohenen. Structure of states according to experimental structural-sensitive data of non-crystalline solids As_2S_3 was revealed, depending on the cooling velocity, which allows determining the spectrum of self-organized structures in the form of a fractal structure. The fractal structure of the bifurcation process of transition to the non-crystalline state and the functional dependence of the structural-sensitive parameters $f(\tilde{q})$ on the reduced cooling rate $\tilde{q} = (q - q_c)/q_c$ in the form

$$f(\tilde{q}) \cong \tilde{q}^{d_f},$$

where the fractal dimension $d_f = 0.631$ is established (Fig. 2, η_m is ordering parameter).

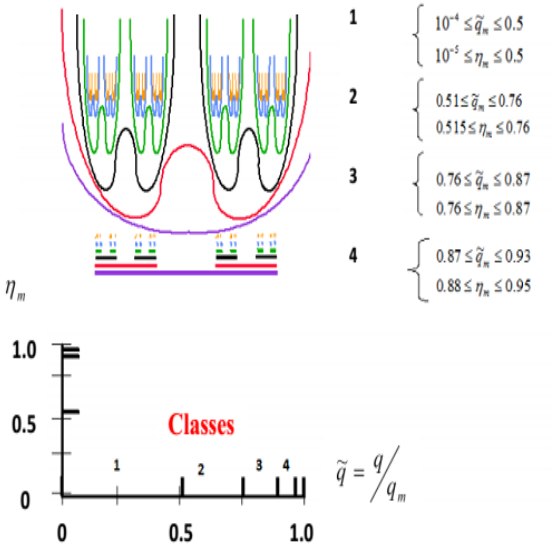

Fig. 2. Classes of fractal structuring for the non-crystalline solids

CONCLUSIONS

Self-organized structures of the non-crystalline materials have a hypersensitive that is related to their informational nature and can be applied to the development of sensory devices for optical recording and diagnostics, the ability to create archival memory and video discs based on them [2-4]. The results of the research of the information component of self-organized structure show that the lifetime τ_{life} owns a fractal structure [2]. This indicated phenomenon defines and forms an extremely unique feature of self-organized structures - is the hypersensitivity. This is extremely important in the development of nano and intellectual materials of the artificial intelligence [4, 5].

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