A Numerical Model of Light Propagation in Porous Composite Structures

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With development of nanotechnologies, an interest in development and investigation of porous materials as the most promising materials in different areas of science is rapidly growing [1]. The best way to find a set of effective physical characteristics of porous composite material is a numerical simulation of corresponding physical processes in the structural model of that material [2]. Such numerical models give the ability to take into account many microstructural heterogeneities of complex porous composites that cannot be done in analytical models [3].

In order to build a complex porous composite model a microlevel cellular model with a porous generation method based on Bezier curve generation was used [4]. The result of such simulation is shown in Fig. 1. The proposed composite structure is described by representative volume element that is a 3D matrix of scalar intensities, diapasons values of which describe different composite components.

To simulate a light propagation in such model the numerical methods of solving differential equations that are a mathematical model of physical process were used. For example, a beam propagation method that was used for light propagation in complex porous structure of composite is depicted in Fig 2.

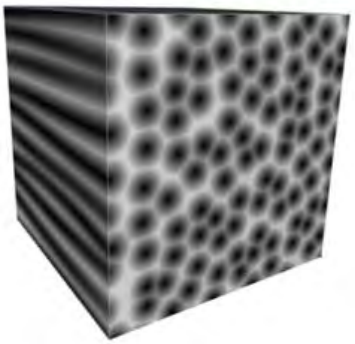

Fig. 1. *Example of porous composite structure*

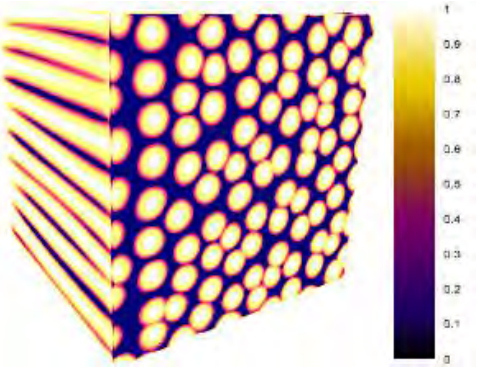

Fig. 2. *Example of light propagation process simulation in porous composite structure*

The results of such simulations can be used for effective refractive index calculation in terms of reverse boundary problem solution. Besides, by using the proposed approach the numerical model of finding the effective optical characteristics in porous matrix composites can be built.

[1] A. Losic, *Nanoporous Alumina. Fabrication, Structure, Properties and Applications*, Springer, 2015, 371 p.

[2] N. Jaworski, I. Farmaga, M. Lobur, P. Spiewak, Research of composite materials optimal design task based on numerical simulation, *Proceedings of the 8th Int. Scientific and Technical Conference on Computer Sciences and Information Technologies*, CSIT'2013, Lviv, Ukraine, 2013, pp. 46-48.

[3] N. Jaworski, I. Farmaga, U. Marikutsa, Building the micro-level composite materials structure models in the problems of their optimal design, *Scientific Bulletin of Ukrainian National Forestry University* **25.8** (2015) 359-366.

[4] N. Jaworski, N. Andrushchak, A method of nanoporous anodic aluminum oxide structure modeling based on Bezier curves generation, *Proceedings of the 14th Int. Conf. on Experience of Designing and Application of CAD Systems in Microelectronics*, CADSM'2017, Polyana-Svalyava, Ukraine, 2017, pp. 63-66.

[5] N.A. Andrushchak, O.A. Buryy, V.T. Adamiv, I.M. Teslyuk, A.S. Andrushchak, A.V. Kityk, Development of crystalline nanocomposites with KDP crystals as nanofiller, *Proceedings of the International Conference on Nanomaterials: Applications and Properties*, Lviv, Ukraine, 2016, Vol. 5, No.2, 02NNSA10(3 pp.).