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ABSTRACT OF THE DOCTORAL DISSERTATION

The main aim of the study was to develop and implement a three-dimensional model of biomaterial pores as a tool for determining pore volume.

The process of creating the model consisted of three main stages. The first was to determine the assumptions that the model should meet. As part of this stage, measurements were performed using the confocal laser scanning microscope LEXT OLS4000. The research material were samples of a porous corundum biomaterial produced by chemical foaming. The images acquired using the microscope were analysed in the SPIP software from Image Metrology, which allowed to segment the pores from the surface image and measure them. Based on the obtained parameters, model assumptions were adopted.

The next stage was implementation. The model was implemented in the Matlab programming environment. To allow the user to enter the input parameters of the model, a graphical user interface was designed and implemented. The user can specify the size of the model, the number of pores and the minimum and maximum pore diameter. Based on these parameters, a three-dimensional model is generated. Another element is the choice of plane and cross-sectional position. By generating the cross-section, the user obtains a surface image showing the pores in the selected plane and cross-sectional position, as well as the parameters characterizing them. The model enables to determine the volume of pores both inside the material and on its surface, which gives the opportunity to determine the volume of open pores and to estimate the mean pore volume per unit area of the material tested.

The last part of the research involved verification of the developed model. The modelling method was tested by comparing the results obtained using the model with experimental data obtained as a result of microtomography of the biomaterial. In the first step, a computer simulation was carried out, resulting in a three-dimensional representation of biomaterial pores. The input parameters of the model were selected in such a way that the cross-section of the material, obtained as a result of intersecting the three-dimensional model with a plane, was

characterized by pore geometry analogous to that obtained during previous analysis of the images of the real biomaterial surface, obtained using the confocal microscope.

Then, the porous corundum biomaterial samples were measured using a high-resolution X-ray scanner. The resulting series of projections was reconstructed, and then three-dimensional images of the samples were generated. In the next stage, image analysis was performed using the Thermo Scientific Avizo software. The analysis made it possible to segment the pores and perform their precise measurements, as a result of which parameters characterizing the pores were determined.

The comparison of the results obtained in both stages of the experiment has shown that the program generates a model with the structure and geometry of pores close to the actual ceramic biomaterial, which confirmed the correctness of the developed model.

Therefore, the model can be used to design a biomaterial with a specific internal pore structure, which will have a specific volume of open pores on the surface. The determined volume will allow, among others, to calculate and then place a specific volume of drug in the open pores of the biomaterial and deliver it to the patient during implantation.