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The Software System for Statistical Modeling of the Porous Structure of Plasma Sprayed Biocompatible Coatings

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The bioactive coating is applied on the surface of the ventplants to enhance their potential capacity of osteointegration. Getting these coatings with known characteristics is a complex problem and it requires a large number of experiments. The paper presents an algorithm and interface software program for statistical modeling of the porous structure of plasma sprayed biocompatible coatings of the ventplants.

Keywords: Plasma spraying, Biocompatibility, Modeling, Porous coatings, Dental implant.

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The ventplants of permanent and temporary service life are widely used in modern odontology and traumatology. [1] To improve the functional characteristics of permanent implants the porous bioactive coating is applied on their surface by plasma spraying.

Forming of the plasma sprayed coating is carried out by creating a stream of accelerated particles heated to a high temperature and placing them on the surface of the bottom (Fig. 1). The internal structure of the plasma sprayed coatings is more complex because of the variety of shapes, sizes and relative positions of solid particles and pores of the coatings [1, 2].

In operation, the implant and the coating are influenced by dynamic loads, resulted in coating tension; they greatly reduce the strength of the coating summarized with the remainder tension originated during the spraying process. An experimental way to determine the values of the tensions is almost impossible, so the construction of mathematical models is used. The process of calculation of such models is a very labor-intensive one and is based on the application of the Monte Carlo method, so it is advisable to carry it out with the help of a computer [3, 4].

The computer program "SSTU Porosity" is created for the calculation of the mathematical models, this program is used in conjunction with a surfaces computer analyzer AGPM-6M and software complex "SSTU DSA 1." The complex "SSTU DSA 1" was created at SSTU in 2005 and designed for semi-automatic control of the surface quality of the ventplants [5].

The program "SSTU Porosity" allows to process the information about the porosity of the test coating and works in the following way:

1. Record images of the field of view of the microscope to the computer.
2. Determination of the radius of pores and particles, the calculation and control of microporosity.
3. Display the results of monitoring the picture of the microscopic objects on the screen.
4. Generate random values of pore radius and the side width of the pores of the coating, based on previously obtained information about the maximum pore radius and the minimum distance between them.
5. Generate random values of loads and moments affecting the implant coating during the operation.

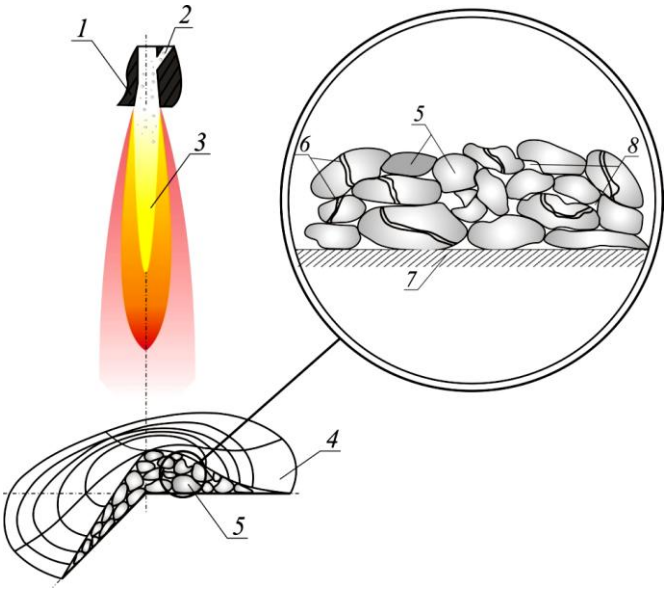

Fig. 1 – The plasma spraying process and the formed coating: 1 is a plasma torch; 2 is the particles of the sprayed powder; 3 is a plasma jet; 4 is a spot of the spraying, 5 is the sprayed particles; 6 is the nanochannels; 7 is the emulsion carrier; 8 is the macropores

6. Calculation of the tensions incipiented in the coating during functional loading.
7. A comparison of the tension values with the strength characteristics of the coating obtained in the experiment.
8. Display the information about the maximum radius pore, the maximum particle size, the quantity of calculated pores and the percentage of injured pores.

A block diagram of the program "SSTU Porosity" is shown in Fig. 2.

Fig. 3 shows a screen shot of the program with the treated photography of the ventplant surface and image processing results.

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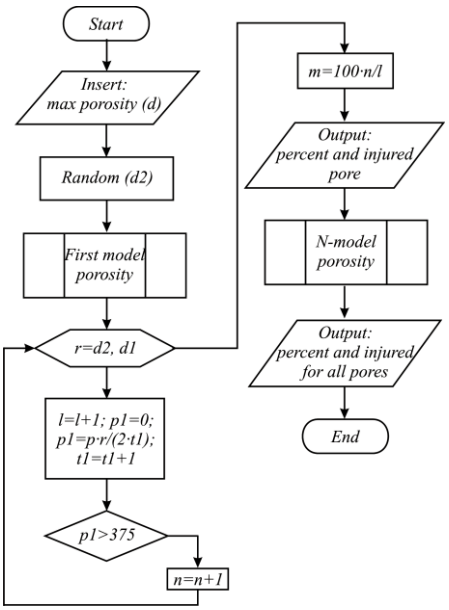
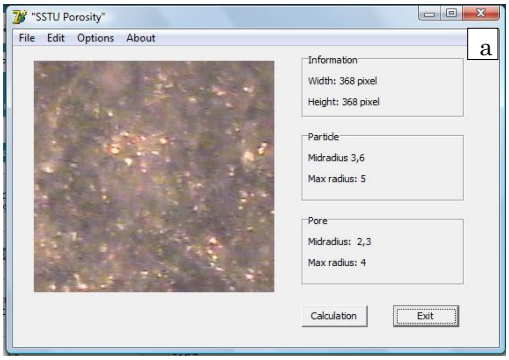


Fig. 2 – A block diagram of the program "SSTU Porosity"



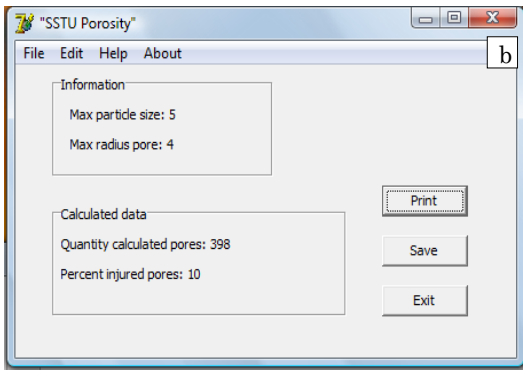


Fig. 3 – The screen shot of the program "SSTU Porosity": a is a photography of the treated surface and calculated data; b is the results of calculations in the program "SSTU Porosity"

The program "SSTU Porosity" is implemented in the programming language Borland Delphi 7 for the operating system Windows (ver. 98 SE, Me, NT 4.0 SP6, 2000, XP, 2003, Vista, Windows 7).

The application requires the following minimum resources:

- OS Windows 98/Me/2000/NT/XP/2003/Vista/7;
- Intel Pentium 200 MHz or higher;
- RAM – 32 MB;
- Free space on your hard drive - 5 MB.

The program "SSTU Porosity" allows to evaluate the strength of plasma sprayed coatings, using the data obtained with the metallographic microscope.

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