[1,2]Y.I. Khodyrevskaya, [2]T.V. Glushkova, [2]Y.A. Kudryavtseva
[1]National Research Tomsk Polytechnic University
Tomsk, Russia
[2]Research Institute for Complex Issues of Cardiovascular Disease
Kemerovo, Russia

Surface morphology of antiadgesive membranes obtained by the electrospinning for medical application

Introduction. Adhesions impose a serious postoperative complication in cardiac surgery, which increases the risk of reoperations. Polymer materials are widely used in modern reconstructive cardiovascular surgery. Development of production and modification methods of polymers and products based on them will be used to solve the important problems of theoretical and practical cardiology [1].

Electrospinning is a promising method of producing antiadhesive membranes. The electrospinning method allows obtaining thin polymer nanofibers, which may contain live cells or special drugs for changing biological properties [2].

Nanofibers are of interest due to the fact that the mechanical properties of materials, such as tensile strength, Young's modulus, elongation are increased when the diameter of the fiber is reduced. The size effect may occur in the volume properties as a result of the additional interaction between the polymer molecules caused by their orientation when the fiber diameter becomes comparable to the length of the molecule. Therefore, reducing the fiber diameter to the submicron level can improve their strength and order.

The aim of the research was to study the surface morphology and physical-mechanical properties of antiadhesive membranes.

Materials and methods. The membranes were produced using 8 % polymer solutions in the electrospinning apparatus Nanon 01A with addition of drugs and without them. Such polymers were used as polyhydroxibutirate/oxivalerate (PGBV) and copolymer polylactic-polyglicolic acid (PLGA). Dipyridamole (DP) was applied as a drug. The fibers structure was studied with the scanning electron microscope Hitachi S-3400. The physical-mechanical tests were carried out with the universal testing machine «Zwick / roell»-2.5N (Zwick GmbH & Co. KG, Germany).

Results and discussion. The membrane structure is essential in assessing the functional properties of the product. The morphology of the membranes made under identical parameters is largely different for coaxial fibers and for usual fibers. Coaxial fibers have a high degree of orientation and larger thickness, as shown in fig. 1. Addition of the drug through the whole thickness of the fiber does not influence the fiber size.

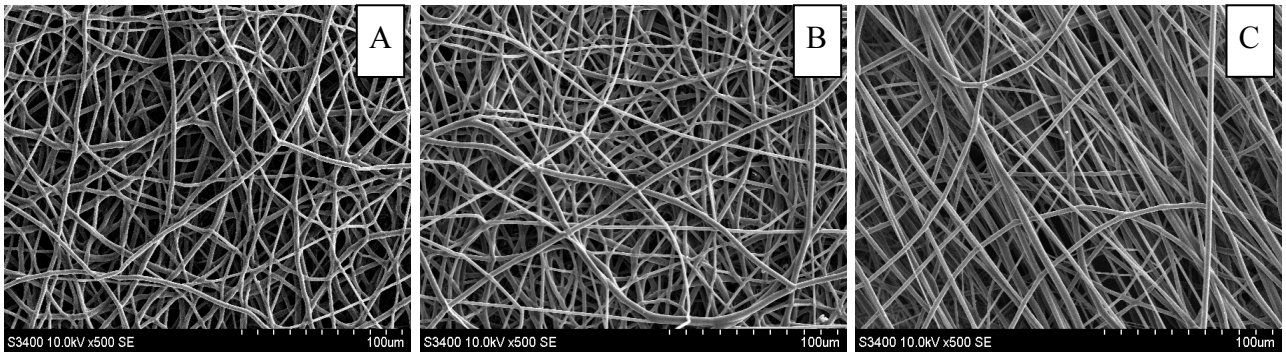

Fig. 1. The surface structure of antiadhesive membranes without drugs (A) and with addition of DP in all thickness of the fiber (B) and inside the fiber (C)

In cardiac surgery, it is very important that antiadhesive membranes could withstand the thrust of moving organs. According to the table, addition of DP allows to reduce the membrane stiffness.

In coaxial fibers, it decreases by 1.9 times, and in typical fibers, it decreases by 4.24 times. However, the tensile strength in typical fibers is less than 1.52 times.

Table

Physical-mechanical properties of antiadhesive membranes

Membrane composition and structure	Tensile strength, MPa	Elongation, %	Young's modulus, MPa
PGBV+PLGA	3.63	3.025	289
PGBV+PLGA+DP (usual fibers)	2.39	28.32	68.1
PGBV+PLGA+DP (coaxial fibers)	3.69	10.01	152

Thus, addition of the dipyridamole inside the fiber can improve the properties of biodegradable membranes.

Conclusion. Wide opportunities of the electrospinning process make possible to receive the fibrous materials with the desired physical properties. Despite the complexity of the study and understanding of the physical processes of electrospinning method, it differs by the instrumental simplicity, high energy efficiency of the nanofiber production, versatility of the formable material and the flexibility of the process parameter control. All this makes the electrospinning process attractive for industrial production of nanofibers.

Nanofibers and materials obtained by electrospinning are used in a variety of areas. Using of the different nozzle allows the desired change in the properties and variation of the morphology structure. The ability of add drugs to form polymeric composition can facilitate rapid healing.

References

1. G.A. Volozhin, Basic types of biocompatible materials, MSMSU Press, Moscow, 2010.
2. S.V. Sheremetev, E.M. Shteynberg, Application of functional polymers in medicine, SibAK Press, Kazan, 2012.

Scientific adviser: S.I. Tverdokhlebov, DSc, Assosiate Professor, TPU, Russia
Linguistic adviser: T.S. Mylnikova, Senior teacher, TPU, Russia