OBTAINING MATERIALS BASED ON A LACTIDE-GLYCOLIDE COPOLYMER FOR THE NEOGENESIS OF BLOOD VESSELS

N.S. Radionov, D.N. Lytkina

Scientific Supervisors: Prof., Dr. I.A. Kurzina

Tomsk State University, Russia, Tomsk, Lenin str., 36, 634050

E-mail: nikolaj-radionov@mail.ru

ПОЛУЧЕНИЕ МАТЕРИАЛОВ НА ОСНОВЕ СОПОЛИМЕРА ЛАКТИДА И ГЛИКОЛИДА ДЛЯ ВОССТАНОВЛЕНИЯ КРОВЕНОСНЫХ СОСУДОВ

Н.С. Радионов, Д.Н. Лыткина

Научные руководители: профессор, д.ф.-м.н. И.А. Курзина

Национальный исследовательский Томский государственный университет,

Россия, г.Томск, пр. Ленина, 36, 634050

E-mail: nikolaj-radionov@mail.ru

Аннотация. *В ходе эксперимента были получены пленки сополимера лактида и гликолида с различными характеристиками поверхности. С использованием методов сканирующей электронной микроскопии и профилометрии, а также методов ИК-спектроскопии установлен состав, структура и морфология поверхности полученных полимерных пленок. Показано образование различных агрегатов на поверхности пленок в зависимости от способа обработки материала. Установлено, что при получении пленок они частично подвергаются гидролизу, а шероховатость образцов зависит от способа обработки.*

Introduction. Polymers currently have a wide application in various areas of human activity. One of the promising directions for the use of biodegradable materials are products and systems for medical application. Most of these products should function in the body solely for a limited time. Lavsan retention sutures, metal stents and fasteners for traumatology and orthopedics, cava filters - all of them, after carrying out their task, require extraction from the body, i.e. conducting an additional operation. Similar products made from biodegradable polymers, after performing their functions, will degrade inside the body, while the products of decomposition are eliminated through metabolic cycles and have no toxic effect [1]. In this case, you do not need to repeat the operation to retrieve the product. But the most relevant are developments in the field of vascular and cardiac restoration, because cardiovascular diseases are the leading cause of death in the world. Therefore, obtaining new materials and creating implants of arteries and veins is an acute medical problem, for which it is also possible to use polymers, while these substances must have different physico-mechanical, hydrodynamic properties and biodegradation time. An appropriate candidate for this role is a copolymer of lactide and glycolide - PLGA. Due to their biocompatibility and special physico-mechanical characteristics, polymers based on lactide and glycolide are used in regenerative medicine as matrices for cell culture, scaffolds, etc. [2]. To synthesize lactide and glycolide polymers with predetermined properties and biodegradation time, it is necessary to establish the relationship between the molecular structure, supramolecular organization and material properties

[3]. Thus, the aim of the research work is to obtain a polymer material from PLGA and investigate their composition, morphology and structure.

Obtaining and Modification. Samples of PLGA were obtained in three stages: dissolution of polymer, films casting and treatment. Copolymer 80 kDa with the ratio of lactide:glycolide = 80:20 was dissolved in excess amount of trichloromethane. Dissolution was carried out for 40 minutes at an approximate temperature of 50-60 °C. The resulting solution was poured into a Petri dish and dried 1 day in air and then placed in a vacuum desiccator with calcium chloride for 2 days at room temperature. The resulting polymer films were processed: 1) 0.1 N NaOH for 10 minutes - PLGA 2; 2) 10 N NaOH for 1 hour - PLGA 3. The obtained samples were compared with the untreated control sample - PLGA 1.

Methods of Investigation. The micromorphology of the surface of PLGA films was investigated by the scanning electron microscopy (SEM) method, a Hitachi TM 3000 microscope (magnification range of 1000-3000) was used with an accelerating voltage of 5 kV. IR-spectra of samples were performed using a spectrometer the Nicolet 6700 with frequencies 500-4000 cm-1. Portable roughness meter TR200 was used to study the morphology and surface roughness of the PLGA samples. The parameter characterizing the surface roughness was chosen Ra - mean arithmetic deviation of the profile.

Results and Discussion. Surface investigation of samples using SEM showed that the untreated surface of PLGA 1 has a lot of spherical inclusions on the surface of 1.8-2.2 μm, PLGA 2 treated with a weak solution of alkali has a surface covered with elongated formations with a width of 1.0-1.2 μm, and PLGA 3 treated with a concentrated alkali solution has a more complex morphology of the surface with large single inclusions of 8-9 μm in size.

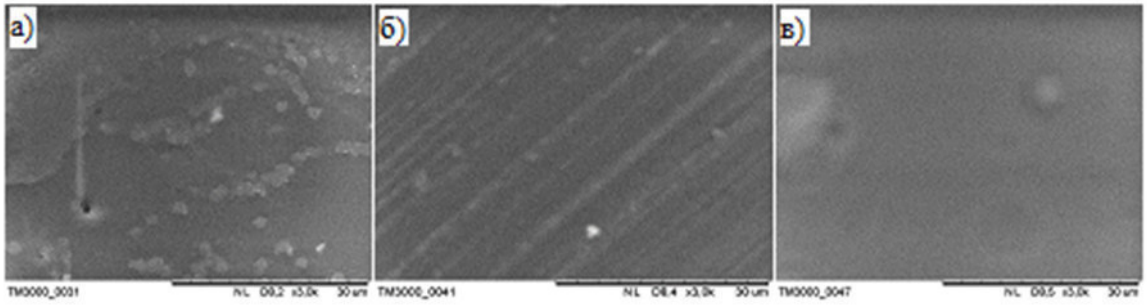

Fig. 1. SEM-microscopy of samples: а) PLGA 1; б) PLGA 2; в) PLGA 3

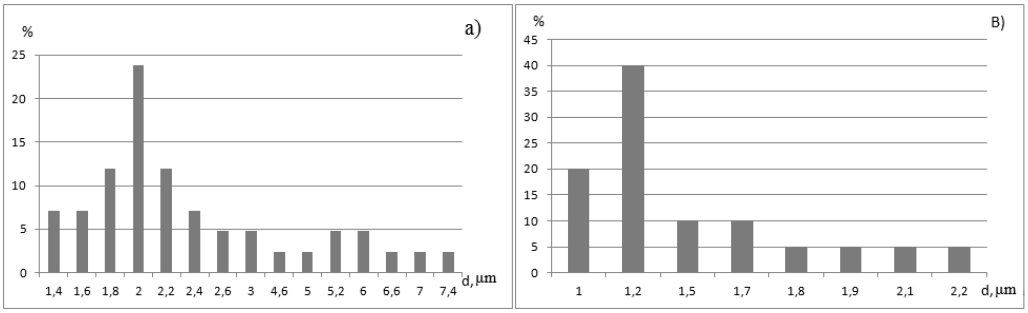

Fig. 2. Diagrams of distribution of inclusions on the surface of samples: a) PLGA 1; b) PLGA 2

Distribution of inclusions on the surface of samples was calculated. Small inclusions with a size of 2 μm predominate on the surface of the untreated sample, smaller inclusions (1.2 μm) predominate on the surface of PLGA 2. Similar inclusions on the sample PLGA 3 were not detected.

IR spectra were obtained for the samples. They showed that all the valence and deformation vibrations of the groups characteristic of the initial monomers and copolymer were observed in the films: -OH at 3500 cm^{-1}, antisymmetric oscillations $-CH_3$ at a wavelength of 2960 cm^{-1}, vibrations of -C=O by 1750 cm^{-1}, oscillations of $-CH_3$ at a wavelength of 1460 cm^{-1}, and oscillations of C-O-C at a wavelength of 1250 cm^{-1}. On the basis of the data of IR spectra, it can be concluded that in the alkali treatment, the samples are partially exposed to hydrolysis, since the intensity of the bands corresponding to the end groups increases.

Analysis of mean roughness values showed that the samples have a smooth surface, with no relationship between the Ra value and the surface treatment time, as well as the relationship between Ra and the alkali concentration. However, profilometric measurements allowed to establish that the values of the arithmetic mean deviation of the profile (Ra) during alkali treatment are reduced.

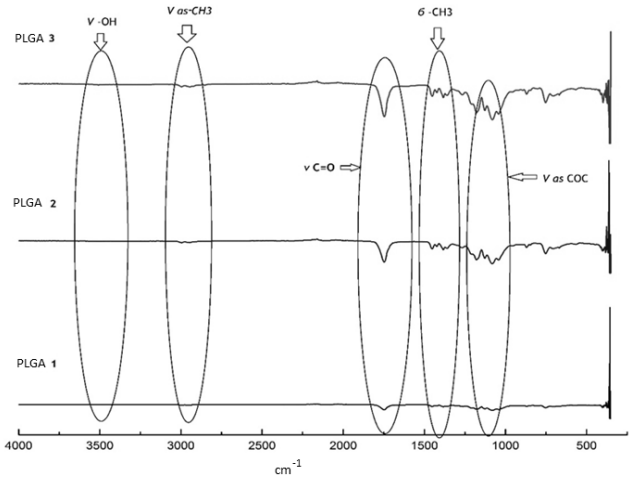

Fig. 3. IR-spectra of samples PLGA

Table 1

Mean arithmetic deviation of the profile for different samples

Sample	**PLGA 1**	**PLGA 2**	**PLGA 3**
R_a, μm	0,5±0,2	0,14±0,04	0,21±0,06

REFERENCES

1. Baimark, Y., Niamsa, N., Morakot, N., Threeprom, J., Srisuwan, Y. (2007). Preparation and Morphology Study of Biodegradable Chitosan/Methoxy Poly(Ethylene Glycol)-b- Poly (ε-Caprolactone) Nanocomposite Films. International Journal of Polymer Analysis and Characterization, 2007, no. 12-6, pp. 457-467.
2. Amini, A.R., Laurencin, C.T., Nukavarapu, S.P. (2012). Bone tissue engineering: Recent advances and challenges. Crit. Rev. Biomed. Eng. 2012, no. 40, pp. 363–408.
3. Botvin, V.V., Ogneva, N.S., Pozdnyakov, M.A., Filimonoshkin, A.G. (2017). Investigation of the mechanism of formation of cyclic diesters of lactic and glycolic acids as monomers for the synthesis of biodegradable polyesters. Bulletin of Tomsk State University, Chemistry, 2017, no. 8., pp. 88-96.