Section 1. INDUSTRIAL TECHNOLOGIES AND EQUIPMENT

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RESEARCH OF FEATURES OF THE COAXIAL ELECTROSPINNING OF NANOFIBERS

ИССЛЕДОВАНИЕ ОСОБЕННОСТЕЙ КОАКСИАЛЬНОГО ЭЛЕКТРОФОРМОВАНИЯ НАНОВОЛОКОН

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ABSTRACT

ELECTROSPINNING, NANOFIBERS, COAXIAL SPINNING HEAD, BILAYERED NANOFIBER STRUCTURES, POLYMERS

The work is devoted to the study of the process of electrospinning nanofibrous materials on the Fluidnatek LE-50 installation using a coaxial spinning head. Rational modes of coaxial electrospinning of nanofibrous materials and coatings by a solution of polyvinyl alcohol were determined for joint and separate operation of the inner and outer needles of the spinning head. The behavior of the electrospinning polymer jet with unequal volumes of fiber-forming solution supply through the external and internal coaxial needles is investigated.

АННОТАЦИЯ

ЭЛЕКТРОФОРМОВАНИЕ, НАНОВОЛОКНА, КОАКСИАЛЬНАЯ ПРЯДИЛЬНАЯ ГОЛОВКА, ДВУХСЛОЙНЫЕ НАНОВОЛОКОННЫЕ КОНСТРУКЦИИ, ПОЛИМЕРЫ

Работа посвящена исследованию процесса электроформования нановолокнистых материалов на установке Fluidnatek LE-50 при использовании коаксиальной прядильной головки. Были определены рациональные режимы коаксиального электроформования нановолокнистых материалов и покрытий путем раствора поливинилового спирта для совместной и раздельной работы внутренней и внешней игл прядильной головки. Исследовано поведение электроформовочной полимерной струи при неодинаковых объемах подачи волокнообразующего раствора по внешней и внутренней иглам коаксиальной прядильной головки.

Nowadays interest in the production of electrospun nano- and microfibers is growing rapidly due to the unique properties and characteristics of the produced non-woven coatings and structures [1, 2]. Electrospinning is a promising method for producing continuous nanofibrous materials using a high potential electric field [3]. A number of specific characteristics, such as a high surface-to-volume ratio, flexibility in surface functionalities and excellent mechanical properties can be achieved only when the diameter of the polymer fiber is reduced to a nanoscale [1, 2]. Of particular interest is electrospinning from polymer solutions and melts, since the obtained fibers have many potential applications [4]. Among the most relevant of them are drug delivery, biotechnology, wound healing, tissue engineering, the creation of dressings, prostheses and medical scaffolds, cosmetics, filtration, the production of energy converters and storage devices, catalysts and enzyme carriers, the creation of protective clothing, sensors, electronic and semiconductor materials and etc.

The aim of this work was to determine the rational modes for producing nanofiber materials using a coaxial spinning head. The aqueous solution of 15 % polyvinyl alcohol Selvol 205 produced by Sekisui Specialty Chemicals Europe S.L. (USA) was used. The electrospinning process is considered as effective when it is stable and provides the maximum performance.

We carried out our investigations of the electrospinning process using Fluidnatek LE-50 device equipped with the coaxial spinning head containing inner and outer needles. This head allows the production of bilayered nanofiber structures therefore it is effective for encapsulating biorelevant nanocomposites and fibers [4]. We consider such elecrospinning process which is carried out with the droplet size at the tip of the needle of the spinning head does not change over time and the process of formation and drawing of the solution jet occurs continuously as a stable electrospinning. The maximum flow rate of the solution was adopted as a criterion for the efficiency of the electrospinning process.

The behavior of the polymer jet and the parameters of the electrospinning process are the same as with the total flow rate while the joint internal and external needles working. We have determined the following rational values of the process parameters that ensure stable production of nanofiber coatings and materials: tip-to-collector distance is 8 cm, voltage is 25 kV for inner needle and 26 kV for outer needle, polymer solution flow rate is 600 µl/hour for single needle operation and 300 µl/hour for their joint work. In this case, at different ratios of the feeding polymer solution through the inner and outer needles, the electrospinning process remains stable and this rational production of nonwoven nanofiber materials: tip-to-collector distance is 8 cm, voltage is 25 kV for external and internal needle and 26 kV for internal needle, the total two needles feeding rate is 600 µl/hour.

These results are relevant for studies on controlling polymer feed rates to vary the concentration of active substance in the material being produced. The revealed features of the coaxial spinning head will allow to create specific materials and coatings for the needs of medicine and aesthetic cosmetology.

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