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POTENTIAL APPLICATION OF ELECTROSPUN POLY (E-CAPROLACTONE) (PCL) NANOFIBERS FOR CONTROLLED RELEASE OF POORLY WATER-SOLUBLE DRUGS

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The targeted drug delivery and controlled release of poorly water-soluble drugs present state-of-the-art researches in nanomaterial science. It is caused, firstly, by the necessity of fast and safe release, secondly, by the necessity of high dosage connected with poor water-solubility. Biodegradable electrospun polymer PCL nanofibers seem to be very promising materials for this application [1, 2]. They have already demonstrated good results in experiments with ibuprofen and carvedilol [3]. The aim of our research is to make experimental samples of electrospun PCL nanofibers for paracetamol and to determine their potential as a novel delivery system for poorly water-soluble drugs.

For the preparation of polymer solutions polycaprolactone (PCL), paracetamol and hexafluoroisopropanol (HFIP) were used. For the preparation of (2 wt/%, 8 wt%, 16 wt%, 32 wt% based on the dry weight of the polymer) paracetamol-loaded PCL solutions previously dissolved in HFIP paracetamol powders were added to PCL granules and then refilled with the rest of the solvent. Electrospinning of nanofibers was proceeding on NANON – 01 (MECC CO., Japan) with a 200 mm diameter drum collector.

To determine the average diameter of the nanofibers SEM images were used. To study a drug release process scaffold’s elements were put into PBS-solution (pH 7.4) for two weeks, at the predetermined time points 200 µl of the solution was withdrawn and replaced with fresh phosphate buffer. Probes were analyzed by HPLC (Agilent 1200 Infinity, Agilent Technologies, USA). SEM imaging of the prepared electrospun scaffolds with an incorporated drug revealed rounded, individual nanofibers with a smooth surface without visible crystals. According to the obtained data a kinetic curve of paracetamol release was formed. The release from the PCL 16 wt/wt. % nanofiber scaffold was fast, reaching more than 97% of the total amount in the first hour.

The obtained results demonstrate that electrospinning can be used for the preparation of highly paracetamol-loaded PCL nanofibers. It is shown that incorporation of such poorly water-soluble drugs, as paracetamol in PCL nanofibrous material leads to their fast dissolution in pH-neutral medium. In conclusion, electrospinning is shown to be a promising approach to the delivery of poorly water-soluble drugs in order to control and enhance their release.

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STRUCTURE OF SALT SOLUTION IN POLAR DIELECTRIC LIQUIDS AND ELECTRICALLY-INDUCED SEPARATION OF SOLVATED IONS

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The aim of the study is to demonstrate that separation of solvated ions in mixed salt solution under the action of the external periodic electric field occurs because of around ions, the clusters having dimensions of ~ 0.1 μm and consisting of the solvent molecules are formed.

In investigation the cluster dimensions were defined theoretically, and the value of frequency of the external electric field, which action excites the effect of the solvated ions separation, was determined experimentally [1-3]. The experiments were conducted at the Technical Physics Department of the National Research Tomsk Polytechnic University.

When determining the dimensions of clusters, Poisson's equation was solved, and it was considered that solvent polar molecules were oriented under the action of electric field of an ion. The chemical composition of the solution sample was determined using the X-ray excited fluorescent radiation analysis method.

Theoretical estimates and experimental results confirmed the assumption, that clusters formed around ions in the solutions, have the dimensions of ~ 0.1 μm.

At determination of the electric field amplitude-frequency parameters, by means of which it is possible to excite an ion-selective mass transfer in solution, we needed correct estimation of the sizes of covers formed from solvent molecules around ions. Thus, the traditional description of solvated ion properties based on the Debye-Huckel approach, led us to the fact that the ion-selective mass transfer in solution had to take place at the frequencies of external electric field of ~ 10 MHz. Nevertheless, really ion-selective mass transfer in solution was excited at frequencies of ~ 100 Hz.

The results of the research have shown that placing of volume distributed electric charge of ion in dielectric liquid is accompanied by the formation of the supramolecular particles called “clusters”, the linear dimensions of which are significantly more than the first and the second radiuses of solvation (~ 1 Angstrom), and reach a size up to ~ 0.1 μm. At such dimensions, the inertial properties of clusters and their natural frequencies give the chance to operate their movement by means of action of the external electric field on the solution.

The conducted theoretical estimation has revealed the possibility of associates (clusters) formation from solvated ions in salt solutions in dielectric liquids. It is probable that the action of external periodic electric field with different intensity amplitudes in half-periods causes the directed motion of not separate solvated ions, but associates-clusters formed by the solvated ion groups. Significantly larger mass of the associate and, consequently, a bigger value of the inertia moment can explain the manifestation range shift of electrically- induced drifting effect of solvated ions towards smaller frequencies at salt concentrations to 10 g/l that comply with the experimental results.

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