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SUMMARY

„Plasma treatment of electrospun nanofibers for medical applications"

Electrospun polymer nanofibers are the examples of materials that can be used in various areas of life due to their useful properties. Nanofibers can be found in many applications as a result of the following unique characteristics – high surface-to-volume ratio, flexibility, light weight, nanometric diameters and small pore size. Investigations into effective methods of modifying nanofibers to further enhance their utility are also being conducted. New methods are being developed to enable processing of finished fiber mats. An interesting possibility is the treatment of nanofibers with the use of non-thermal plasma, which provides a significant modification of the physical properties of the surface-treated layer.

The aim of the dissertation was to apply the electrospinning technique to fabricate nanofibers from polymers important for medical applications and to examine the effect of non-thermal plasma treatment on the properties of obtained nanomaterials.

Cellulose acetate and polycaprolactone were selected as base polymers. The polymer solutions were doped with methylene blue (MB), which is a well-known photosensitizer and in the presented dissertation it was used to prepare sterilizing materials under the influence of visible light. In the case of nanofibers obtained from polycaprolactone, halloysite was additionally used as a carrier for the controlled release of methylene blue.

A system for the electrospinning of nanofibers was developed that enables the regulation and measurement of the values of process variables: capillary supply voltage, solution dosing rate and the capillary-collector distance. The electrical properties of solutions and polymers (or composites) were described by their volume resistivity. The start and stop voltages of the process for which the polymer solution stream was stable and the electrospinning process proceeded without disruption were determined.

The modification of nanofibers was carried out using non-thermal plasma generated in air, at atmospheric pressure, in a dielectric barrier reactor. The power density of the discharges and their interaction time with the polymer material were adopted as the processing parameters. The results of the conducted research confirmed that plasma treatment of nanofibers allows improving their wettability and sorption properties. These parameters are important and crucial for the suitability of nanofibers as wound dressing materials. Plasma modification was also used to treat the surface layer of halloysite. It was shown that both non- and plasma-modified halloysite was negatively charged, regardless of the pH of the environment, and therefore it can be an effective carrier of cationic substances (here MB).

It has been found that plasma treatment of halloysite affects its ability to bind MB. As a result, the release of MB from nanofibers containing plasma-modified halloysite was more effective than that nanofibers with unmodified halloysite. Moreover, it was demonstrated that treatment of polymer nanofibers and halloysite with non-thermal plasma affects the intensity of the halloysite adsorption process on the nanofiber surface.

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PhD student signature