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ABSTRACT

Preparation of electrospun polymer fibers for biosensor and photonic applications

Electrospun nano- and microfibers exhibit unique properties, such as high surface area to volume ratio, porosity and ease of fabrication, which, combined with the ability to control their morphology and possible functionalization, render them useful in a wide range of fields and technologies, such as sensors and biosensors, as well as photonics and optoelectronics.

The primary objective of the doctoral dissertation was to produce electrospun polymer nano- and microfibers with potential applications in biosensorics and photonics. Additionally, a key aspect was to modify obtained materials to grant them the properties necessary for the intended applications.

In the course of the research, an attempt was made to optimize the electrospinning process using solutions of three base polymers: polyacrylonitrile, poly(vinyl alcohol) and poly(methyl methacrylate) (PMMA), which allowed the production of fibers with a uniform structure, without defects, and with a diameter below 2 μm, and consequently, PMMA was selected as the base polymer for further research.

In the next stage of the research, the electrospun fibers were modified by doping them with organic dyes (characterized by light emission in the red, green and blue range, upon excitation with UV light), as well as newly synthesized polycyclic compounds, granting them additional properties that enable applications in photonics and biosensors.

The potential for practical use of the produced materials was examined by producing multilayer, electrospun luminescent materials with the potential to generate white laser light. The dissertation also presents the concept of an enzymatic electroanalytical system based on the fabricated, modified fibers, which allows for the determination of the neurotransmitter - dopamine - in aqueous solutions.

The results presented in the doctoral dissertation show the potential of electrospun, modified polymeric materials for applications in biosensors and photonics. Materials doped with polycyclic compounds can be used in the design and development of analytical detection systems, and multilayer systems doped with dyes present a promising basis for further research towards generating white laser light.