

Summary

Modern medicine presents scientists with challenges related to the development of advanced materials featuring complex, multifunctional biological properties. A particularly important and demanding research direction involves creating biomaterials that combine antimicrobial activity with the ability to modulate blood clotting processes, which may enhance wound treatment effectiveness, reduce infection risk, and accelerate tissue regeneration.

The aim of this Doctoral Dissertation was to develop methods for modifying fibrous polymer materials by incorporating selected metals such as copper, zinc, or iron into their structure. The research hypothesis assumed that purposeful functionalization of fibrous material structures with metals would improve their biological properties, particularly by increasing antimicrobial activity and enabling control over hemostatic parameters.

The Dissertation consists of a cycle of eight monothematic scientific publications published in journals indexed in the Journal Citation Reports (JCR). These papers present original methods for biomaterial functionalization as well as detailed analyses of their physicochemical and biological properties. The conducted research employed both chemical methods of metal deposition and physical surface modification techniques using magnetron sputtering processes.

The experiments carried out as part of the Doctoral Dissertation enabled the development of materials with controlled and optimized parameters, exhibiting desirable bioactive properties. The results contributed to a deeper understanding of functionalization processes and the mechanisms responsible for antimicrobial and coagulation activity in materials, opening new perspectives for their practical applications in medicine and related fields.

The work employed interdisciplinary research methods from materials engineering, chemistry, biochemistry, and microbiology, including: scanning electron microscopy with elemental composition analysis (SEM/EDS), flame atomic absorption spectrometry (FAAS), inductively coupled plasma mass spectrometry (ICP-MS), surface property analysis using Brunauer-Emmett-Teller (BET) isotherms, UV-Vis spectrophotometry, as well as biochemical tests (prothrombin time - PT, activated partial thromboplastin time - aPTT), TBARS assay, and comet assay to assess DNA damage in PBMCs. Microbiological studies included assessing the influence of the developed materials on the growth of representative bacterial and fungal strains.