

PhD. Thesis Title

The use of Zirconium for controlled drug release

PhD. Student Pharm. Ramona-Daniela Radu (Duşman)

PhD. Advisor Prof. Dr. Ioana Demetrescu

PhD. Advisor in co-tutorship Prof. Dr. Doina Drăgănescu

Abstract

ZrO₂ nanostructures have shown great potential as drug delivery systems, and there is growing interest in developing them for biomedical applications.

The study showed that using the electrospinning method, PCL fibers were successfully deposited on the Zr substrate, and Vancomycin, MTZ, and TC were incorporated into the PCL fibers. Zr-PCL-MTZ, Zr-PCL-TC, and Zr-PCL-Vancomycin exhibit favorable morphological and chemical properties for use as controlled drug delivery systems.

The antibiotic release profile confirmed sustained and efficient release, essential for maintaining long-term antibacterial activity. Both MTZ and TC exhibit an initial rapid release, followed by a more gradual and sustained release. The Zr-PCL nanofibers demonstrate a promising controlled release profile for metronidazole and tetracycline, governed primarily by diffusion through the polymer matrix.

The antibacterial efficiency was validated through tests against *Escherichia coli* and *Staphylococcus aureus*, demonstrating the potential of these structures in preventing infections associated with medical devices. The results indicate a strong correlation between the morphological structure of the nanofibers, surface properties, and antibacterial efficiency, supporting the use of this technology in biomedical applications.

Overall, the future prospects of ZrO₂ nanostructures as drug delivery systems are promising and could have a significant impact on the field of medicine. However, further research is needed to fully understand and optimize their properties and behavior *in vivo*.