PREVLAKE ZA MEDICINSKA POMAGALA, KIRURŠKE KONCE I ELEKTROISPREDENE PREĐE

ANTIMICROBIAL COATINGS FOR MEDICAL DEVICES, SURGICAL THREADS AND ELECTROSPUN YARNS

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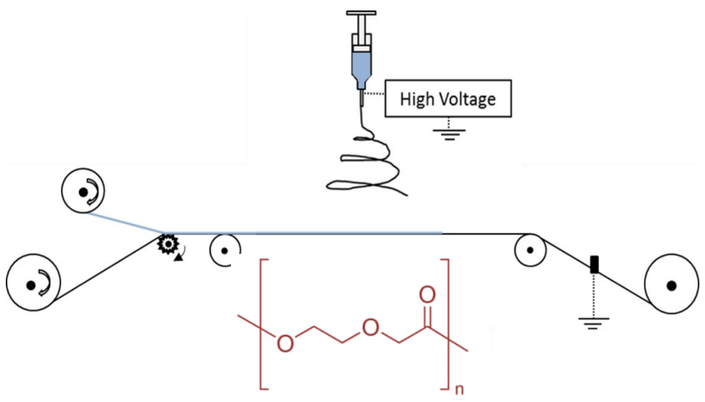
20 međunarodni znanstveno-stručni skup Ružičkini dani
DANAS ZNANOST – SUTRA INDUSTRIJA
18. – 20. rujna 2024. I Vukovar, Hrvatska

ABSTRACT

The rise of antibiotic-resistant bacteria and the high incidence of hospital-acquired infections necessitate the development of advanced antimicrobial coatings for medical applications1. This research focuses on the creation and optimization of antimicrobial coatings for medical devices, biocompatible surgical threads, and electrospun yarns. By employing various techniques such as sol-gel processes and dip-coating methodologies, we have successfully integrated antimicrobial agents, including metal nanoparticles (Ag, Pt, Au, TiO2, ZnO), into these materials without compromising their mechanical properties. The tensile tests indicate that the mechanical properties of the coated electrospun filament yarns remain unaffected, while preliminary antimicrobial tests demonstrate significant efficacy against Methicillin-resistant Staphylococcus aureus (MRSA) and Methicillin-sensitive Staphylococcus aureus (MSSA) when applying optimized formulated mixture of antimicrobial nanoparticles. Scanning Electron Microscopy (SEM) reveals the need for ultrasonic homogenization steps to ensure uniform distribution of nanoparticles. This study highlights the potential of these coated materials in reducing infection rates and enhancing the performance of medical devices and surgical implements. Future work will focus on optimizing the homogenization process and expanding the range of antimicrobial agents to further improve the effectiveness and biocompatibility of these innovative materials

EXPERIMENT & RESULTS

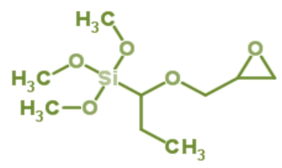
Electrospinning of polydioxanone (PDO)



Stretching, drawing, twisting filaments into yarns

Sol-gel process **+ DoE / RSM**

GLYMO($C_9H_{20}O_5Si$ **+ Ag, Pt, TiO_2, ZnO NPs**

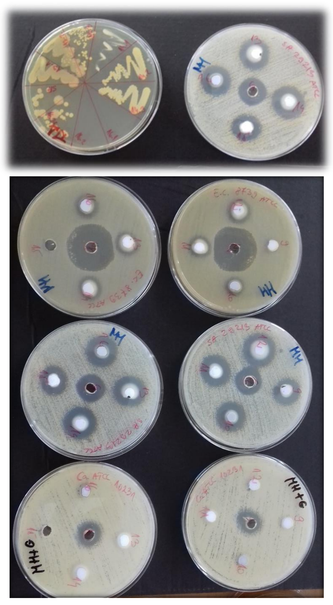


1 h, 20 °C, 350 o/min

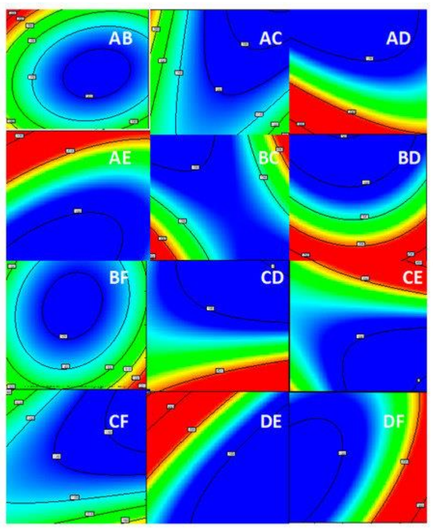
Dip-coating, 1 mm/s

Modified samples were left to gel at room temperature for 24 h, and were then dried at 40 °C for 1 h.

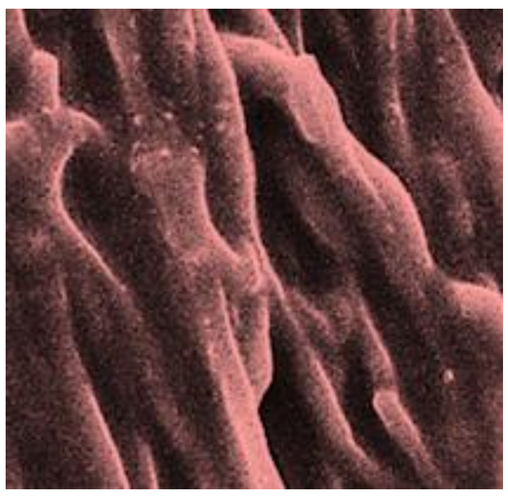
Antimicrobial effects



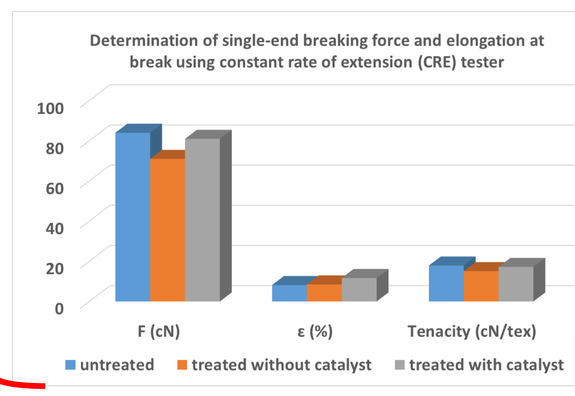
DoE, RSM



FTIR-ATR, SEM-EDX, ICP-MS



Tensile tests



CONCLUSIONS

The obtained results proved that by DoE and RSM methodologies antimicrobial effects are optimized, and that the most efficient antimicrobial results are achieved with the mixture of nanoparticles. Additionaly, optimization of sol-gel modification of PDO electropsun filament yarns can be successfully performed by dip-coating methodology using ultrasonic homogenization prior deep coating with GLYMO as precursor and acid 0.1M HCl catalyst, with a mixture of nanoparticles (Ag, Pt, TiO_2, ZnO) without the degradation of the yarns or loosing some of their mechanical properties. The tensile tests show that the mechanical properties of the electrospun filament yarns were not affected by sol-gel process – not by increasing but also not by significant decreasing, which makes this treatment a possible strategy for producing antimicrobially active implantants. Moreover, the preliminary results of antimicrobial investigation showed very good antimicrobial activity against MRSA and MSSA antimicrobial strains, while SEM images showed non-uniform distribution of nanoparticles and their agglomeration on PDO filaments without sonication pretreatment.

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This work was supported by the Croatian Science Foundation, project IP-2019-04-1381 „Antibacterial coating for biodegradable medicine materials ABBAMEDICA“

HRZZ Croatian Science Foundation