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THE DEVELOPMENT OF FUNCTIONAL COATINGS ON METALS FOR BIOMEDICAL APPLICATIONS

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Introduction. Nowadays, the development of functional coatings on metals are still of interest. These innovations play a pivotal role in enhancing the performance and biocompatibility of medical devices. Notably, the use of titanium dioxide (TiO_2) nanotubes and magnesium particles is prominent for fabrication of prospective and bioresorbable implants.

Nanostructured titania nanotubes are of considerable interest in biomedicine. These TiO_2 nanotubes formed by anodization are characterized by their large surface area relative to volume, outstanding mechanical robustness, and superior chemical steadiness. These makes them suitable for diverse uses like drug delivery mechanisms, antimicrobial layers, and substrates for improved cellular attachment and proliferation. Additionally, their compatibility with biological systems and ability to enhance bone integration render them especially valuable in orthopedic and dental implantology [1-3].

Another type of functional coatings exhibiting substantial potential are based on magnesium particles. Magnesium is known to be a biodegradable metal. Thus, magnesium particles confer advantageous attributes to the coating such as encompass augmented biodegradability, diminished inflammatory reactions, and enhanced bone repair and regeneration. Coatings based on magnesium are especially beneficial in transient implant scenarios, where there is a need for obviating a secondary surgical procedure to extract the implant. [4-5].

Main part. In present study, the kinetics of drug release for model pharmaceutical substances such as tetracycline hydrochloride and eosin B from titanium dioxide nanotube (TNT) and from a mesoporous TiO_2 layer (TMS) have been investigated. The TNTs were synthesized by anodization of biocompatible grade VT-1-0 titanium. A meshed cylindrical platinum electrode served as the cathode. The electrolyte was composed of ethylene glycol solvent containing 0.2 wt.% ammonium fluoride and of 18 μL of H_2O. The experiment was conducted using a two-stage regime. The first stage involved a gradual increase of voltage at a rate of 1.43 V/min. During the second stage, the process was carried out at a constant voltage of 40 V for 60 minutes. The TMS surface was fabricated by sonication in 4.5 M NaOH aqueous solution using the ultrasonic amplitude of 23% .

The release kinetics was studied using pristine TiO_2 nanotubes. The release of tetracycline hydrochloride and eosin B was investigated over various time intervals ranging from 1 to 360 minutes.

For preparation the biodegradable coatings, the magnesium particles were modified sonochemically in a water at an amplitude of 95% for 30 minutes. The acquired samples were subsequently analyzed using Scanning Electron Microscopy (SEM) and X-Ray Diffraction (XRD), and a parameter database was compiled for future application in predicting the fundamental parameters of the system.

Conclusions. The study is focused on the release kinetics of tetracycline hydrochloride and eosin B from TiO_2 nanotube sand a mesoporous TiO_2 layer. It has been established that the release of loaded substances occurs in two stages. There is a rapid release of tetracycline or Eosin B within first 1-30 minutes. While the remaining 40% of the substances releases much more slowly, which contributes to prolonged drug delivery. The release of antibiotic from mesoporous titanium dioxide is found to be slower compared to nanotubes. This phenomenon could be due to their different morphology. The investigation of drug release kinetics and the modification of magnesium particles under specific conditions contribute to a deeper understanding of these materials' interactions with pharmaceutical substances.

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