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A STUDY OF SELECTED PROPERTIES OF A TANTALUM-BASED COATING FOR A NITI ALLOY FOR CARDIOVASCULAR IMPLANTS

Keywords: NiTi alloy, ALD coating, Tantallum Oxide

Introduction

Various types of heart defects can be treated with occluders, made of NiTi alloy. The use of this alloy, despite its good biocompatibility and pseudoelasticity effect, is associated with the risk of allergies, blood clots or problems occurring during tissue hypertrophy. To reduce these negative effects, it was proposed to modify the surface by applying a tantalum oxide coating by ALD to a substrate subjected to electrochemical polishing. Atomic layer deposition (ALD) is a thin-film deposition technology based on the successive application of a gas-phase chemical process. Two precursors, Tantalum Ethoxide $Ta(OC_2H_5)_5$ and water (H_2O) undergo sequential, self-limiting reactions with the surface of a material one at a time.

Materials and Methods

The chemical composition of the coating was confirmed using X-ray photoelectron spectroscopy (XPS), in ultra-high vacuum using a PREVAC EA15 semi-spherical electron energy analyzer equipped with a 2D-MCP detector. Due to the nanometer order of magnitude of the coating, spectral ellipsometry was used to measure its thickness. Adhesion of Ta_2O_5 coating to the substrate was tested by scratch test using an open platform equipped with CSM's Micro-Combi-Tester in accordance with the recommendations of PN-EN ISO 20502:2016-05. The cytotoxicity was measured by cell viability test was carried out according to the recommendations of ISO 10993-5:2009 on fibroblasts (L929 ATCC).

Results

The chemical composition of the resulting coating was 30.2% Ta and 69.8% O. The thickness of the Ta_2O_5 coating was 13.8 nm. The formed coating also showed great adhesion to the substrate. To complement physicochemical studies, biological tests were performed. The results of the cytotoxicity tests showed a beneficial effect of the coating on the properties of the test material.

Conclusion

A thin layer of tantalum oxide has the potential to improve the properties of implants for the heart with complex shapes.