Improvement of the interface between TiAlV and organic tissue through TiO_xC_y organometallic multilayers coatings for improving osseointegration

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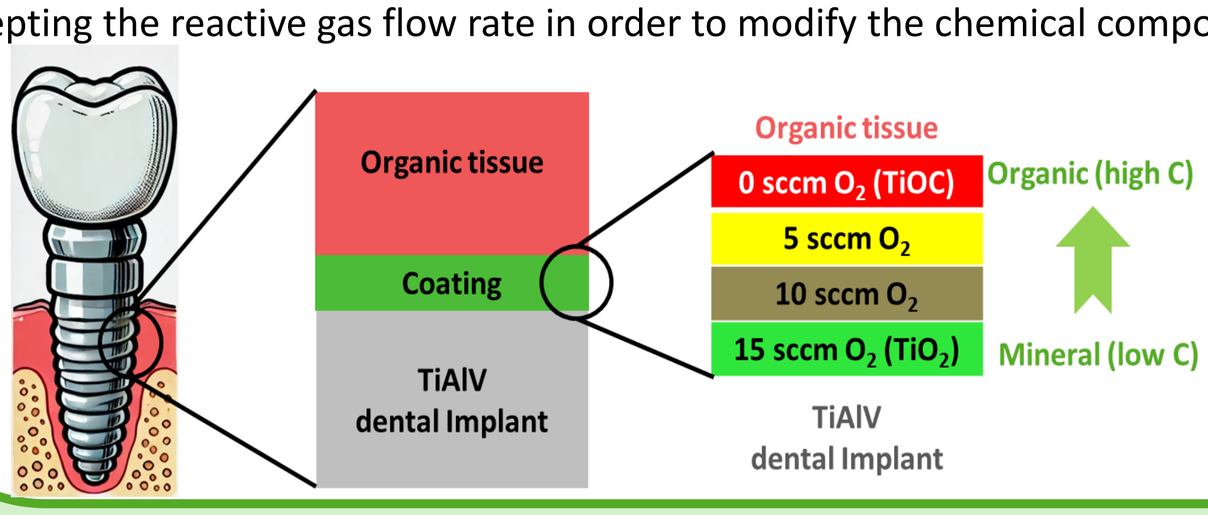
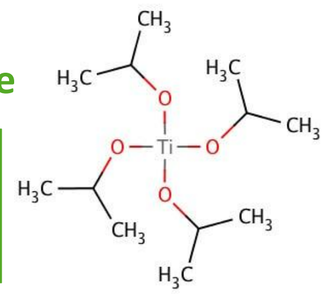
Introduction and Methodology

Titanium alloys like TiAlV are biocompatible materials widely used in dental implants [1]. The interface between the tissue and the metallic screw is of great importance, optimizing chemical properties is crucial for promoting osseointegration and improving dental implants success rates [2].

The research focuses on creating innovative TiO_xC_y organometallic multilayer coating with different carbon composition, varying from mineral (low C) to organic (high C) on $Ti_{90}Al_6V_4$ substrates to improve osseointegration. These coatings are prepared using Plasma Enhanced Chemical Vapor Deposition (PECVD), with the same parameters such as inert gas flow, power and time excepting the reactive gas flow rate in order to modify the chemical composition along the multilayer.

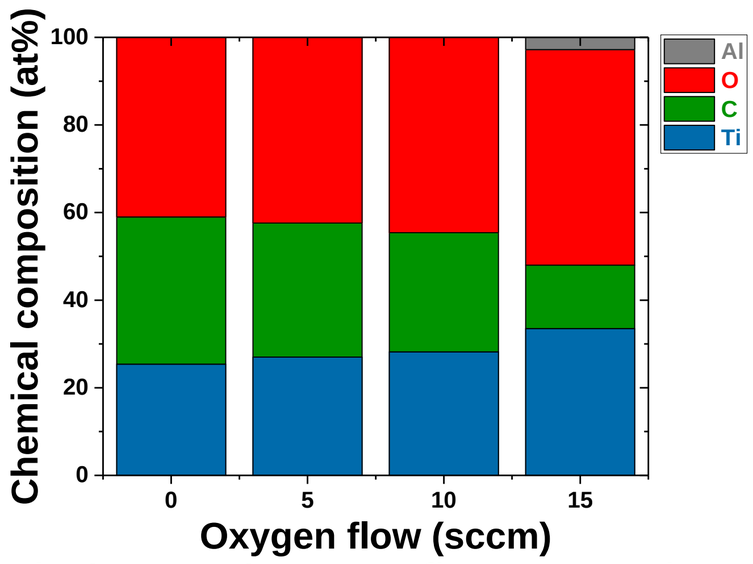


Precursor: Titanium isopropoxide



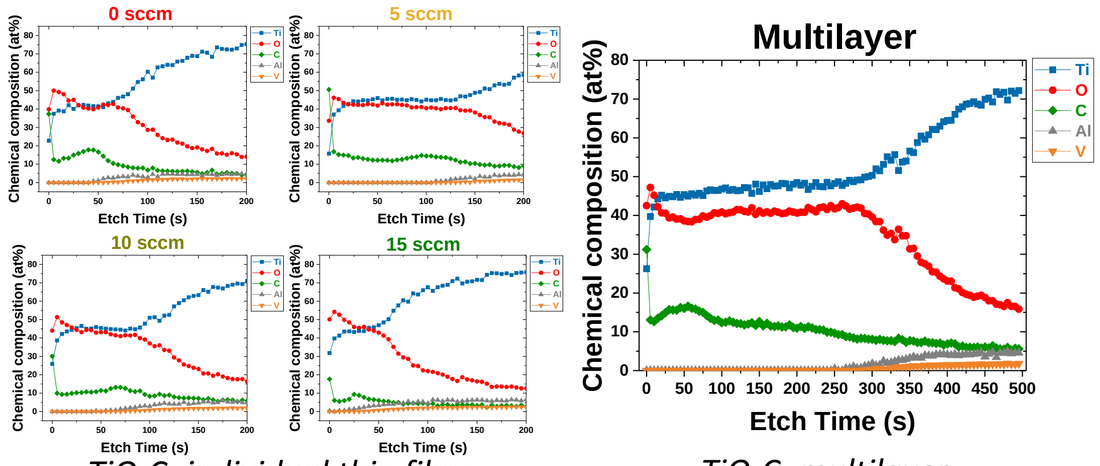
Power: 100 W	**Time: 10 min/layer**	
Ar Flow: 5 sccm	**O_2 Flow: 0 - 15 sccm**	**Temperature: 65°C**

XPS individual films surface



The increase in oxygen flow rate results in a reduction in carbon

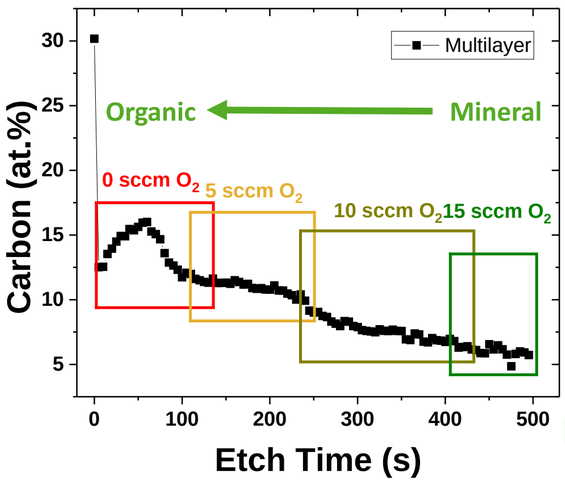
XPS profile (films and multilayer)

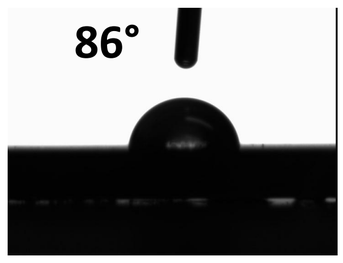


TiO_xC_y individual thin films *TiO_xC_y multilayer*

Preservation of Ti:O stoichiometry and controlled carbon gradient by modification of the oxygen flow rate
Reproducible and scalable multilayer architecture

TiO_xC_y Multilayer coating





Contact angle

Hydrophilic-neutral surface

The oxygen promotes the decomposition of the precursor to deposit a carbon gradient $TiO_{0.9}C_y$ multilayer as function of oxygen flow

Conclusions

A **carbon gradient $TiO_{0.9}C_y$ multilayer** coating was successfully developed on $Ti_{90}Al_6V_4$ substrates via PECVD by modulating oxygen flow rate.

XPS confirmed a **constant Ti:O ratio** and a controlled carbon reduction with increasing oxygen. **This gradient enables a transition from mineral (carbon-low), on the zone close to the substrate, to organic (carbon-high) on the surface**.

The multilayer reproduced the properties of individual layers, showing reproducibility in composition, thickness, and wettability. These features suggest **the coating is suitability** for enhanced protein adsorption and osteointegration, supporting its **application in dental implants**.

References:

[1] Marin, E., & Lanzutti, A. (2023). Biomedical applications of titanium alloys: a comprehensive review. Materials, 17(1), 114.

[2] Gittens, R. A., Scheideler, L., Rupp, F., Hyzy, S. L., Geis-Gerstorfer, J., Schwartz, Z., & Boyan, B. D. (2014). A review on the wettability of dental implant surfaces II: Biological and clinical aspects. Acta biomaterialia, 10(7), 2907-2918.

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