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Surface engineering of Ti6Al4V alloys by bioactive coatings

M.C. Uvida[1,*], M.E. Lombardo[2], S.R. Fernandez[2], D. Mantovani[2], P. Hammer[1]

[1]São Paulo State University, Araraquara, SP, Brazil; [2]Laval University, Quebec, QC, Canada

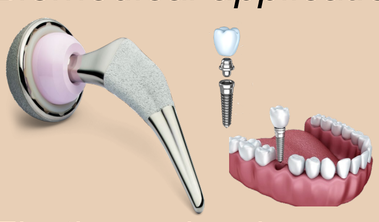
*e-mail: mayara.uvida@unesp.br

coatings MDPI

INTRODUCTION

Ti6Al4V alloy

Biomedical application



Fixation and replacement of bone tissues in orthopedic and dental implants

DISADVANTAGES

- *Toxicity: release of Al^{3+} and V^{5+} ions*
- *Bioinert surface*
- *Biofilm formation*

PROPOSED STRATEGY

Develop **surface modification strategies** for titanium alloys using **multifunctional barrier coatings** containing **bioactive** and **bactericidal compounds**

BENEFITS

- **PMMA-silica coating:** Reduces ion release (Al and V) and improves corrosion resistance
- **Hydroxyapatite and β-tricalcium phosphate:** Mimics bone composition, promotes enhanced bioactivity and biocompatibility
- **Silver phosphate:** Prevents infection

CONCLUSIONS

- Coatings with excellent anticorrosion protection in SBF (Simulated Body Fluid)
- HA, β-TCP and Ag_3PO_4 promoted cell proliferation and osteogenic expression (Alkaline phosphatase ↑ 86.6%)
- Bioactivity confirmed by apatite deposits
- Effective antibacterial and antibiofilm activity against *E. coli* and *S. aureus*
- Synergy between additive was essential for the multifunctional properties
- Promising coatings for Ti6Al4V implants

ACKNOWLEDGMENTS

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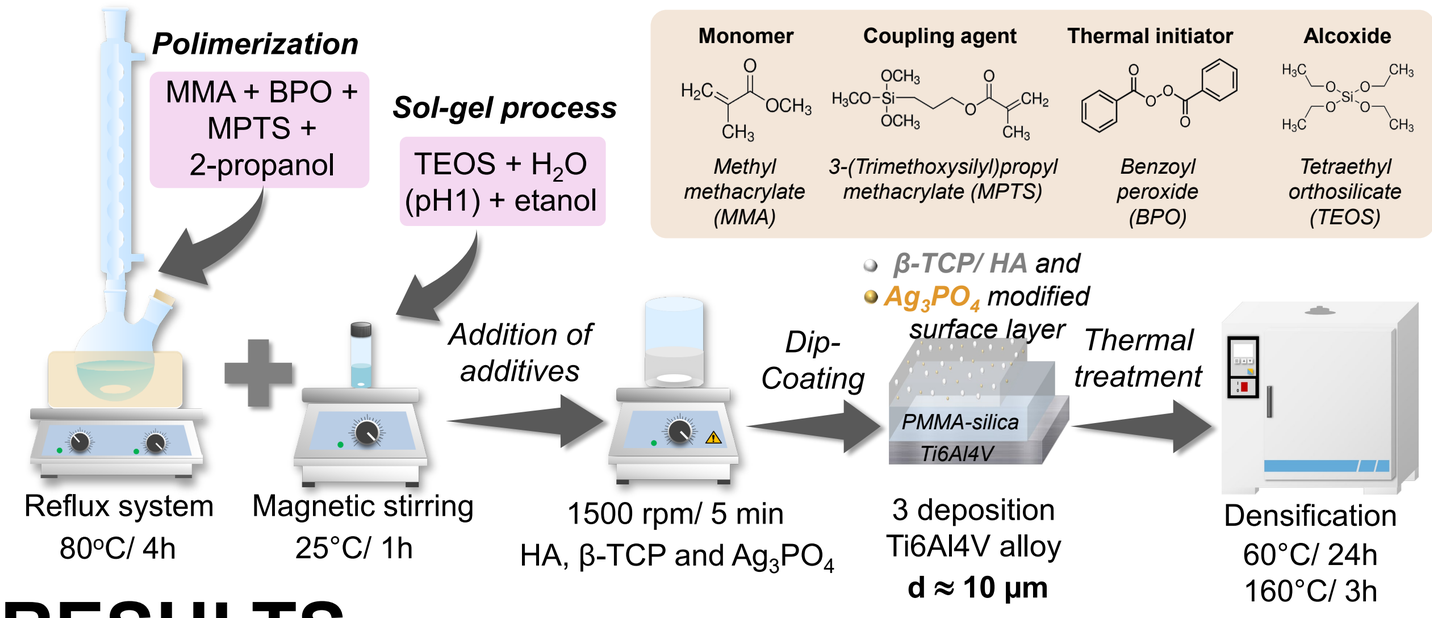
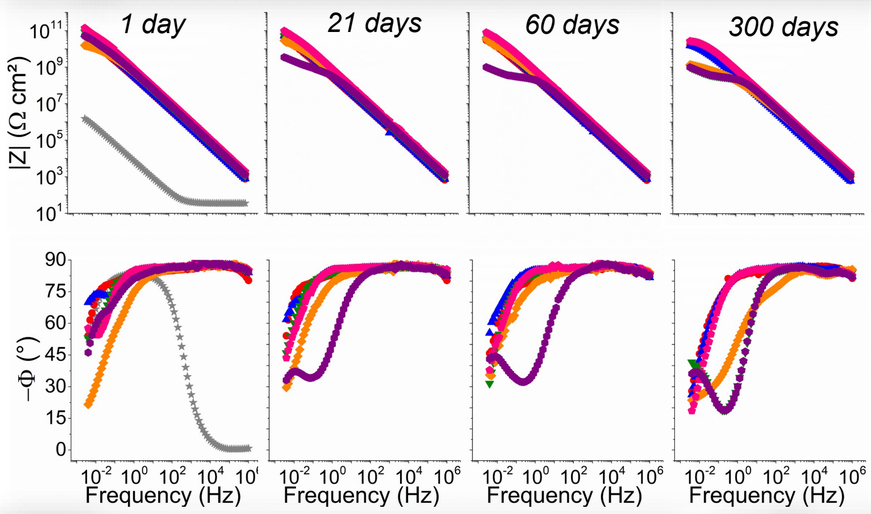
MATERIALS AND METHODS



RESULTS

1 Corrosion protection in simulated body fluid (SBF) solution



PMMA-silica
PMMA-silica-Ag_3PO_4
PMMA-silica-5HA-Ag_3PO_4
PMMA-silica-5βTCP-Ag_3PO_4

- Excellent anticorrosive performance
- |Z| @ 4 mHz for 300 days >10 GΩcm²
- Phase angle close to -90°

PMMA-silica-10HA-Ag_3PO_4
PMMA-silica-10βTCP-Ag_3PO_4

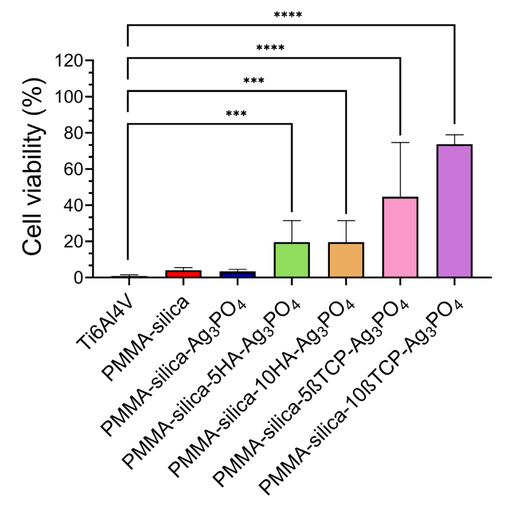
- |Z| @ 4 mHz after 300 days ≈1 G Ωcm²

2 Biocompatibility

After 7 days:

Higher cell viability compared to control

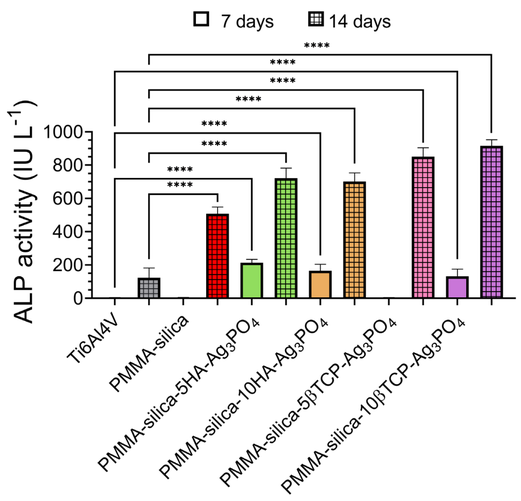
SaOS-2 cells continue to proliferate

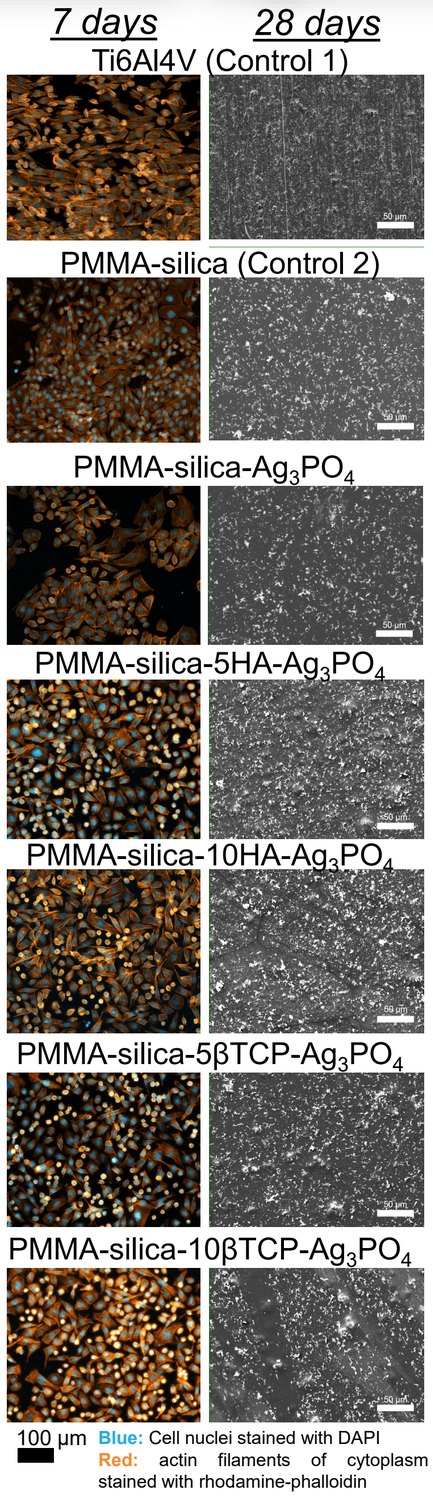


7 to 14 days:

Increase in alkaline phosphatase (ALP) activity compared to controls

Biomarker of bone formation

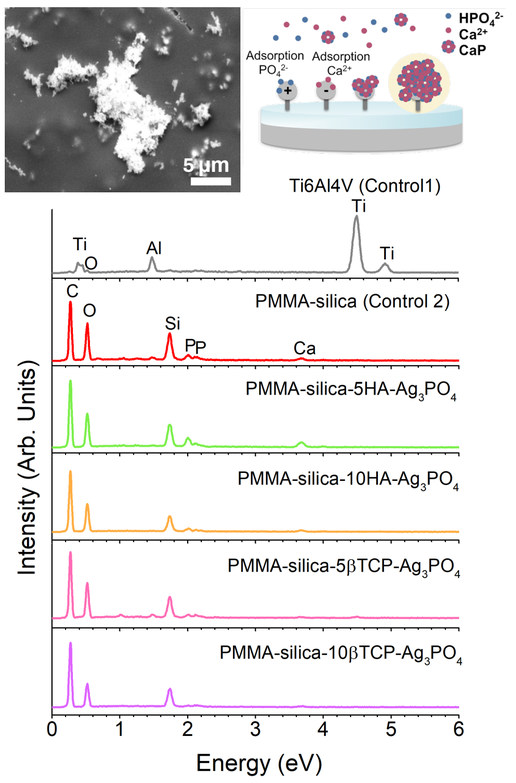




3 Bio- and bactericidal activity

After 28 days in SBF (Simulated Body Fluid):

Material's ability to form a bone like-apatite layer



Reduction in bacterial growth of up to 97% compared to uncoated Ti6Al4V