Free Session

Surface modifications

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Functionalization and coating of Ti6Al4V with extracts or compounds of natural origin for increased tissue integration, antibacterial action or modulation of inflammatory response

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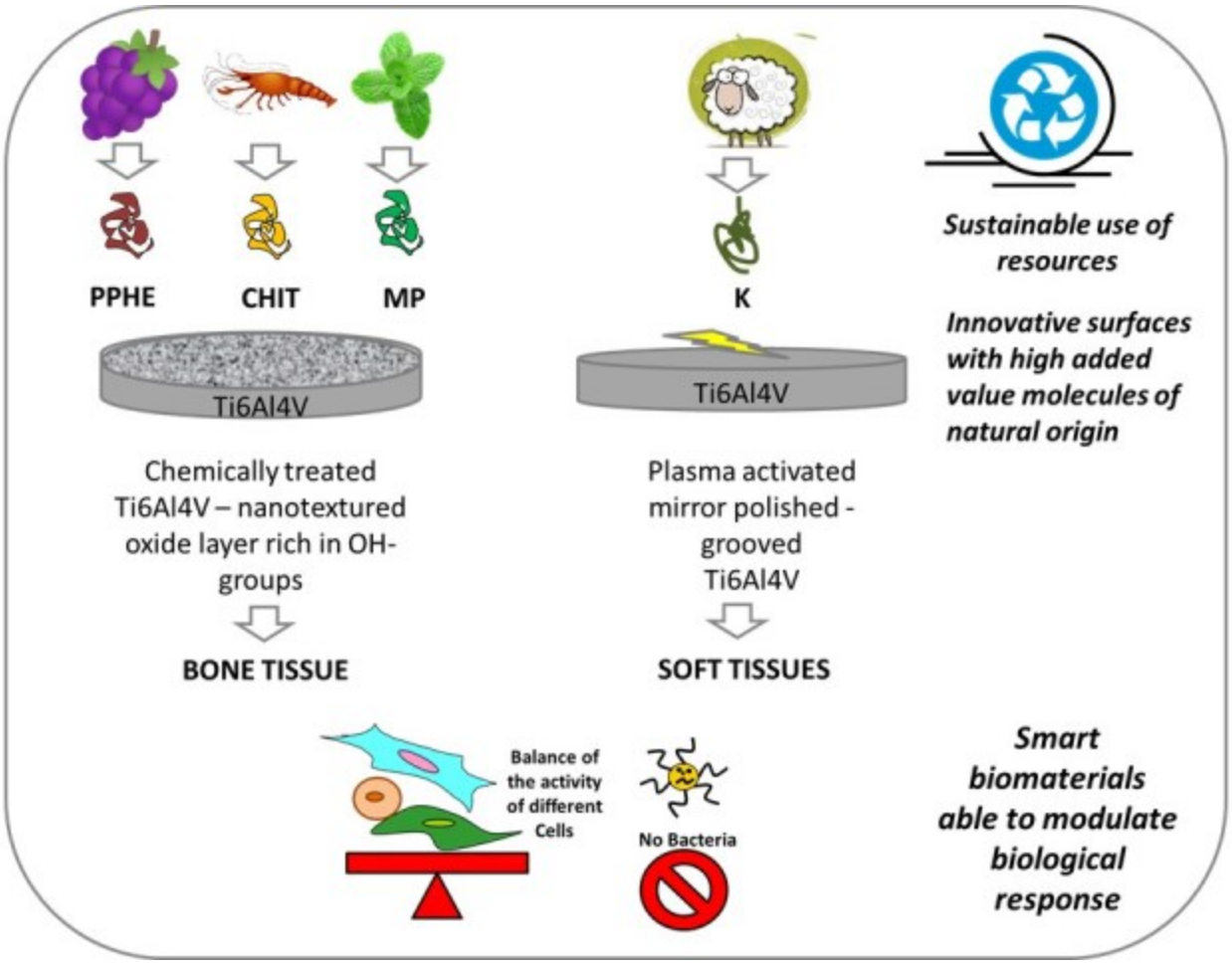
Introduction: The aim of the research is exploitation of the great potential benefits of extracts or compounds of natural origin (polyphenols, essential oils, keratin, chitosan) by coupling them to Ti6Al4V alloy. Both functionalization (surface grafting of molecules) or coating (continuous or as fibers) have been explored. A local action or delivery can be obtained together with the increase of biomolecule stability and bioavailability. Final results are enhancement of mineralization in bone cells, contact guidance of fibroblasts, redox and radical scavenging activity, anti-bacterial action and modulation of inflammatory response.

Experimental methods: Ti6Al4V surface un-treated, plasma irradiated or chemically treated [1] was used as substrate for:
1) functionalization with an extract of polyphenols from grape pomaces (Ti64-F-PPHE),
2) functionalization (Ti64-F-MP) and continuous coating (Ti64-C-MP) with essential oil of peppermint mentha,
3) functionalization with keratin (Ti64-F-K) and coating with random or oriented keratin fibers (Ti64-C-K),
4) continuous coating with chitosan (obtained from Genis hf; Ti64-C-PDC)

Specific protocols of synthesis were developed case by case; characterization was performed through FTIR, SEM, AFM, XPS, fluorescent microscopy, Folin & Ciocalteu test, DPPH, contact angle, zeta potential titration measurements, HPLC, GCMS, tape test, *in vitro* microbiological tests with bacteria (*S. aureus)* and different types of cells (UMR-106, RAW264.7, hFOB1.19, HGF, MG-63).

Image:



Results and discussions: Un-treated Ti6Al4V surface has not functional groups suitable for chemical grafting. In order to improve functionalization ability, a nanotextured oxide layer rich in OH-groups has been obtained by a chemical treatment [1] and natural biomolecules grafted with high chemical stability for an increased biological response of bone tissue (Ti64-F-PPHE: increased mineralization, redox and radical scavenging activity) or antibacterial action (Ti64-F-MP).

The explored surface chemical treatment can be also effective in order to get good adhesion and high coverage of Ti6Al4V by a continuous coating for modulation of inflammatory response, bone stimulating action (Ti64-C-PDC) and/or antibacterial effect (Ti64-C-MP).

On the other side, surface activation through plasma irradiation can be effective in order to functionalize or coat Ti6Al4V alloy with keartin (Ti64-F-K, Ti64-C-K), effective on fibroblasts for higher adhesion and contact guidance effect (as fibers) on soft tissues; doping with silver ions can also add antibacterial properties.

Cytocompatibility with different cells were verified case by case and some critical issues are discussed. Sterilization effect and stability during storage were tested.

Conclusions: Natural compounds, oils and extracts with plant or animal origin were successfully grafted to Ti6Al4V alloy through functionalization or coating. The obtained surfaces are of interest in contact with bone and soft tissues. Some cytocompatibility issues have to be considered case by case. The use of natural molecules and compounds is in line with a sustainable use of resources and the valorization of local economies.

References/Acknowledgements: [1] S. Ferraris J.Mat. Sci.: Mat. Med. 22 (2011) 533-545

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