

BIO-ACTIVATION OF TITANIUM BY POLYMER IMMOBILISATION

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Introduction

To date, critical bone defects have been treated by implantation of a bio-inert metal such as titanium (Ti) or nickel-titanium alloys. The surface of such biomaterials is in direct contact with the host tissue and thus plays a critical role in determining biocompatibility. There are several reports indicating that osteointegration of these implants is not optimal. In order to improve the integration of implants, it is desirable to control interfacial reactions such that tissue-healing phenomena can be controlled.[3]

Our goal is to develop polymers that can be used as a stable bio-active coating for porous Ti scaffolds.

Keywords: biomaterials – tissue engineering

Materials and methods

To achieve such a stable polymeric coating, we have applied a four-step-procedure: (1) cleaning, (2) oxidation and (3) silanisation of the titanium surface followed by (4) polymer immobilisation. Methacrylamide modified (bio)polymers with cell-interactive properties were synthesized and immobilised on the silanized Ti surface by dip-coating and cross-linking through e-beam irradiation.

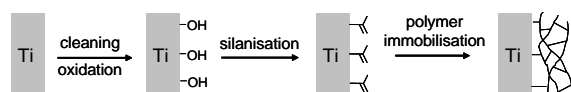


Fig 1. Covalent binding of polymers to Ti.

The polymers developed were mainly characterised by ¹H-NMR spectroscopy. Presence and stability of the polymer coatings were determined through XPS, SCA, AFM and SEM analyses.

Results and discussion

A biopolymer, gelatin, and a synthetic polymer, poly[N⁵-(2-hydroxyethyl)-L-glutamine] (PHEG), were provided with methacrylamide side groups (Gel-mod

and PHEG-MAm) and successfully immobilised onto Ti following the described procedure. Even more, the applied polymer immobilisation process is reproducible and leads to a stable coating (in a buffer solution at 37° for at least 24h). A collagen coating was used as a reference. This biopolymer was immobilised onto the Ti surface in an adsorptive and in a covalent manner.[1,2] Only the latter proved to lead to a stable coating.

To further improve the bio-activity of the gelatin-coated Ti scaffolds, they were coated with fibronectin (FN), a cell-interactive protein, for which gelatin has binding sites.[4] The gelatin-FN interaction was studied by Surface Plasmon Resonance (SPR), Quartz Crystal Microbalance and Dissipation (QCM-D) and radiolabelling studies.

Finally, the synthetic polymer PHEG can act as a carrier for bioactive peptides. In a first approach a peptide was coupled to the polymer by using a PEG-spacer. The second approach was based on thiol containing peptides, which can be coupled to amine containing polymers through the use of an SPDP-linker. Therefore, the copolymer poly[N⁵-(2-hydroxy-ethyl)-L-glutamine-co-(2-aminoethyl)-L-glutamine] was synthesized.

References

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