DECHEMA FORSCHUNGSINSTITUT

Surface Modification of Ti 13Nb 13Zr by Plasma Electrolytic Oxidation

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Introduction

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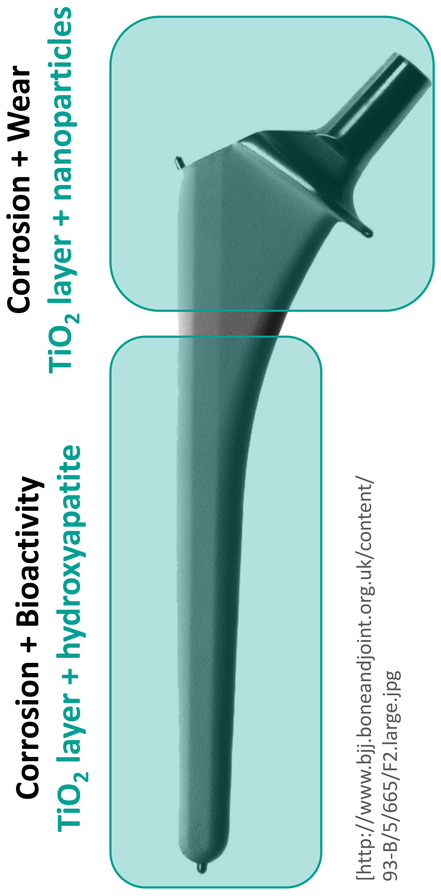
- Titanium alloys used as standard material for biomedical **implant technologies**
- Excellent corrosion resistance and acceptable biocompatibility
- Problem: damage of thin passive layer leads to corrosion, wear and release of harmful metal ions (e.g. Al, V)
- Plasma electrolytic oxidation (PEO) improves **corrosion behavior + wear resistance** of the material
- Thickening of titania passive layer
- Improved osseointegration by formation of **biocompatible hydroxyapatite**
- Enhanced mechanical properties by incorporation of **ceramic nanoparticles**

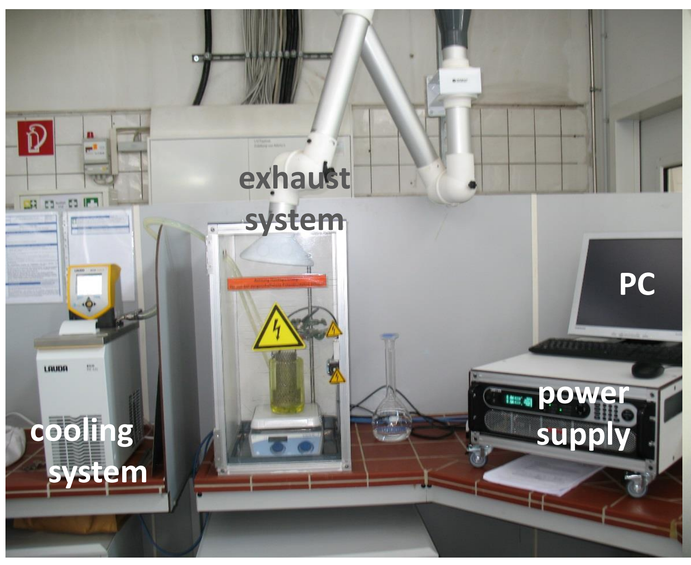


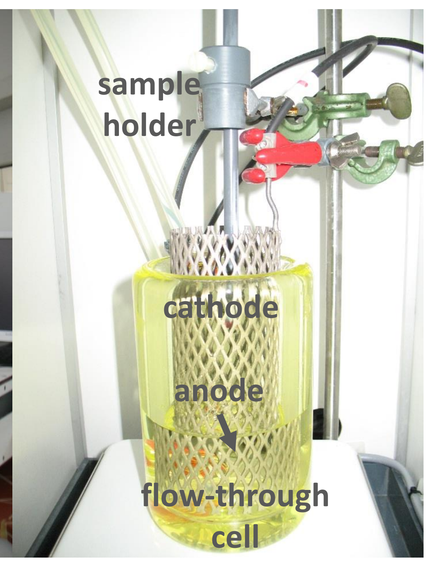
[http://www.bjj.boneandjoint.org.uk/content/93-B/5/665/F2.large.jpg

Experimental

2

- Coating technique: **Plasma Electrolytic Oxidation (PEO)**
- High potentials (~100-800 V) and current densities(~10-1000 $mAcm^{-2}$) applied → exceeding the material's dielectric breakdown potential U_B^*
- Formation of a dense, crystalline ceramic layer
- Influence of **current density** $\boldsymbol{i}$ and **charge density** $\boldsymbol{\sigma = \int i\,dt}$ investigated





Results

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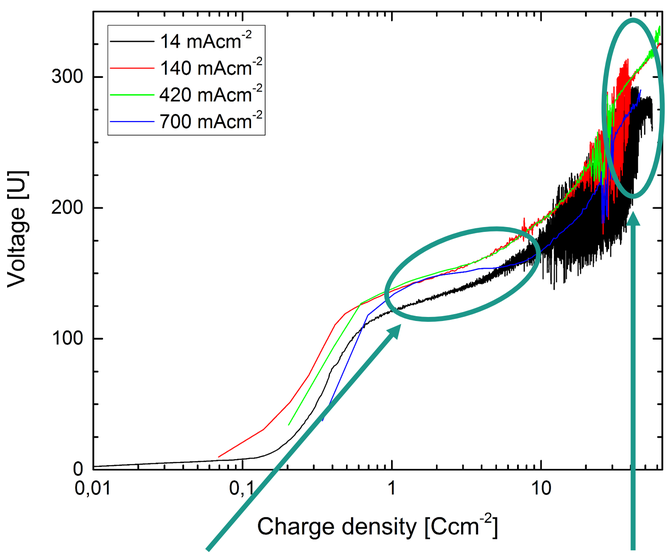
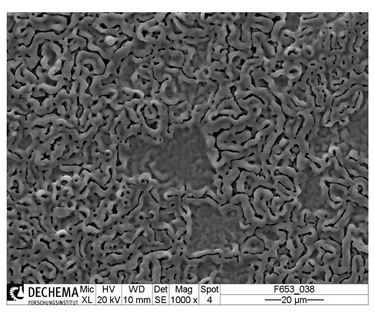
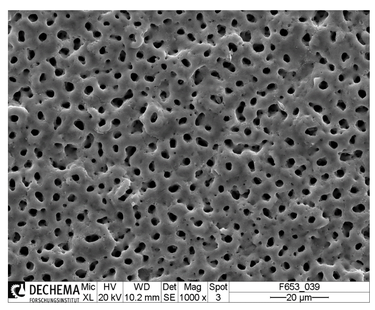
Coating formation



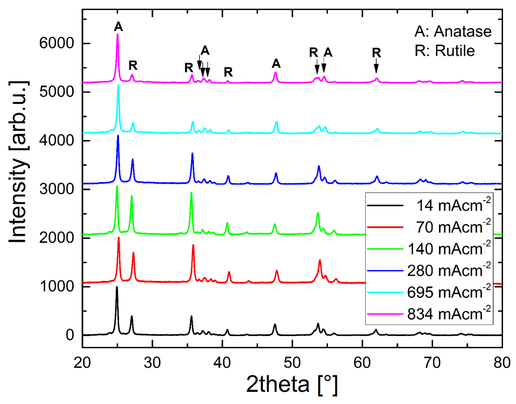


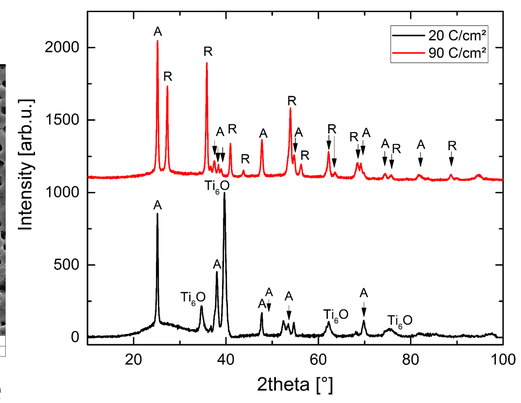
Grooved pore structure
~12.5 Ccm^{-2}



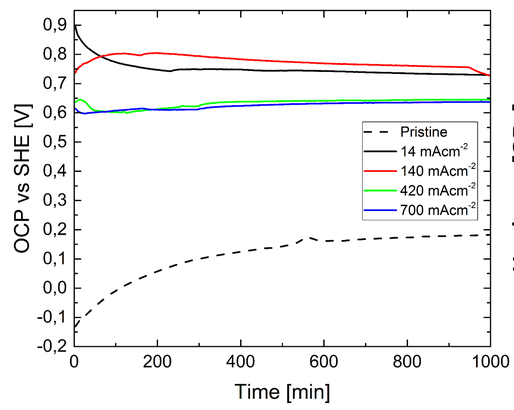
Crater-like pore structure
~62.5 Ccm^{-2}

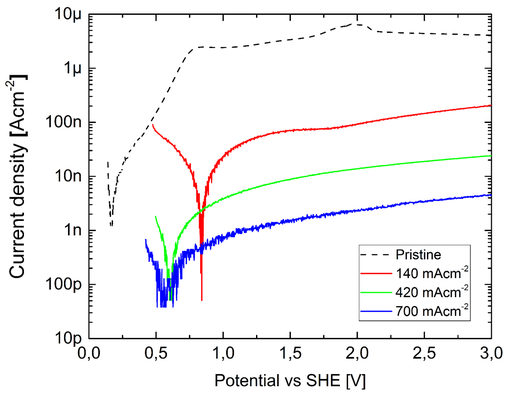
Phase analysis



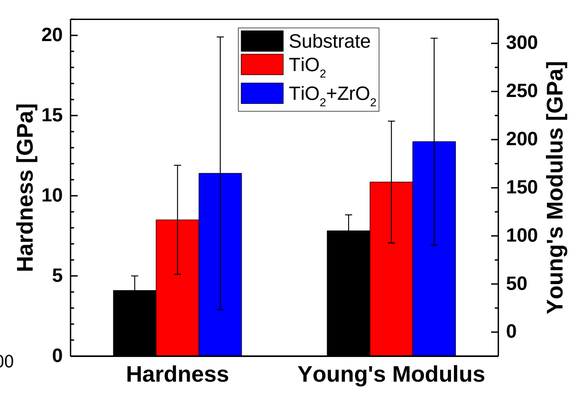


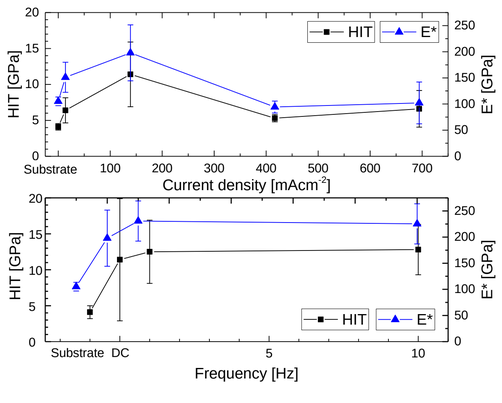
Corrosion resistance





Mechanical properties





Conclusion

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- Variation of surface morphology depending on applied charge density; transformation from grooved surface structure to crater-like, homogeneous surface
- Formation of crystalline titania layers consisting of rutile and anatase; phase composition depends on current density and charge density
- OCP stabilization in all samples after initial decrease due to residual oxidation of defects
- Decrease of i_{corr} with increasing PEO current density @ σ=const. due to increasing coating thickness
- Enhancement of mechanical properties by incorporation of monoclinic ZrO_2 nanoparticles with H_{av}=11.4 GPa and E^*_{av}=200 GPa

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