

Defense announcement

Public Defense on 03 June 2024

Performances of novel biomaterials in simulated biological conditions

Title of the doctoral thesis	Evaluation of <i>in vitro</i> degradation and associated risks of novel biomaterials for implants
Content of the doctoral thesis	<p>The thesis explores innovative approaches to enhance the performance of orthopaedic metallic alloys by addressing the electrochemical behavior related to simulated post-implantation inflammatory conditions. The work comprises a detailed comparison between commercial purity titanium (Ti Group 2 alloy), Ti-6Al-4V alloy (Group 23) and novel Ti-Nb-Zr-Si (TNZS) alloy. Electrochemical studies conducted in various media, mimicking normal, inflammatory, and severe inflammatory conditions. The major media differences were mimicked by varying concentration of H₂O₂, albumin, and lactate. The outcomes indicate i.a. a superior corrosion resistance of TNZS attributed to the presence of silicide phases. In addition, for Group 2 and Group 23 alloys this work examines the electrochemical behavior of additively manufactured (3D printed) patterned titanium layers made of titanium powder of the same composition. For this case, the results reveal an improved corrosion resistance in 3D patterned specimens compared to untreated titanium alloys surfaces.</p> <p>For analysis of more innovative methods of the improvement of the corrosion behavior of metallic alloys tantalum coated with Mn₃O₄ nanoparticles and 3D patterned titanium with alginate hydrogels laden with octacalcium phosphate (OCaP) particles were studied in these simulated inflammatory media. It was observed that electrophoretic deposition of Mn₃O₄ nanoparticles on anodized tantalum demonstrates superior corrosion protection for implants in inflammatory conditions, and potential corrosion protection mechanism has been suggested, highlighting nanoparticles' catalytic activity and sealing role, offering valuable insights for developing corrosion-resistant implant materials. For hydrogel-coated titanium alloys, improved hydrophilicity and OCaP phase crystallinity were observed and an effective reduction of corrosion current density has been found, emphasizing the potential of such coatings to mitigate inflammatory-associated corrosion.</p>
Field of the doctoral thesis	Materials Processing and Powder Metallurgy
Doctoral candidate and contact information	M.Sc. Aydin Bordbar Khiabani aydin.bordbarkhiabani@aalto.fi
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Remote defence	https://aalto.zoom.us/j/66864363051
Place of public defence	Aalto University School of Chemical Engineering, Lecture hall Ke2 (Komppa-Sali), Kemistintie 1, (main door at Biologinkuja) Espoo
Opponent(s)	Professor Gabriela Graziani, The Polytechnic University of Milan, Italy
Custos	Professor Michael Gasik, Aalto University, School of Chemical Engineering
Link to electronic thesis	https://aaltodoc.aalto.fi/handle/123456789/51
Keywords	Novel biomaterials; metallic implants; surface modifications; composite coatings; electrochemical behavior; inflammatory condition