

Biomedical Technologies and Innovation Doctoral Programme (BIOTIN)



Title of the PhD Project	Ti-based smart materials for load-bearing biomedical implants
Acronym	SMARTLANT
Research Fields of the Project	Materials Science, Biomaterials
Keywords	Titanium; Surface functionalization; Antimicrobial properties; Stimuli-responsive materials
Host Institution, Department and Campus Location	Izmir Institute of Technology, Department of Materials Science and Engineering, Urla, Izmir.
PhD Awarding Institution and Graduate Programme	Izmir Institute of Technology, Graduate School, PhD in Materials Science and Engineering
Name and Affiliation of Main Supervisor	Prof. Fatih Toptan (IZTECH)
Name and Affiliation of Co-supervisors	Asst. Prof. Deniz Tanıl Yücesoy (IZTECH) Assoc. Prof. Duygu Ege (BOUN)
Research Environment and Infrastructure	IZTECH is among the top research universities in Turkey. Several projects are currently being performed in MSE in the fields of ferroelectric, piezoelectric, multiferroic materials, advanced ceramic materials, biomaterials, nanomaterials for drug delivery and semiconductors. IZTECH has all the key facilities to process, characterize and test smart Ti-based implant materials that will be developed during the project.
Scientific Context of the Project	Ti and its alloys are the most common materials in orthopaedic and dental implants. However, some major clinical concerns are still valid, namely bone resorption due to stress shielding, lack of bioactivity, harmful effects after intense release of metallic ions and wear debris due to low tribocorrosion resistance, and infection, resulting in the need of a premature revision surgery. This PhD work aims at finding integrated solutions to these issues by developing novel Ti-based highly-porous smart composites, that will (i) reduce stress shielding by its low Young's modulus, (ii) increase bioactivity by its micro-porous bioactive TiO ₂ film, (iii) increase tribocorrosion resistance by hard reinforcing phases having healable bioactive surfaces, that will give bioactivity under normal loading and high wear resistant under local excess contact pressures, and finally (iv) reduce infection risk by pH-sensitive agents encapsulating antimicrobial particles, that will release antimicrobial agents only when infection occurs. In this way, the development of smart surfaces

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	with on-demand anti-wear and antimicrobial properties will be addressed for the first time in this work.
Brief Workplan	<p>Month 1-12: Processing of Smart antimicrobial agents</p> <p>Month 6-23: Bio-functionalization by MAO</p> <p>Month 11-35: Biological response</p> <p>Month 13-36: Electrochemical and trbo-electrochemical mechanisms</p>
Innovative Aspects of the Project	<p>The SMARTLANT project offers a highly challenging, innovative and original concept of smart hip stem in order to increase the lifetime of the implant materials and increase the life quality of the patients. The innovative nature of the project is based on its on-demand antimicrobial properties.</p> <p>Various pH-sensing systems are rapidly evolving, particularly for biomedical applications; however, the development of MAO-treated smart surfaces with the on-demand releasing capability of antimicrobial species will be addressed for the first time in this work. We claim that an intelligent surface that can regulate the release of antimicrobial agents and support the load in a way to minimize tribocorrosion damage can be a big step in avoiding infection and degradation on biomedical implants.</p>
Training Opportunities of the Project	Young students and researchers will be involved in the project that will benefit from the networking and complementary scientific expertise of the international research team, which will add value to their career development.
Interdisciplinary Aspects	Biomaterials science is an interdisciplinary field requiring close cooperation between material scientists and biologists. A multidisciplinary team is formed within this project by gathering researchers having backgrounds in metallurgical engineering, materials scientists and biologists. The team has long experience on the development of biofunctional surfaces, triboelectrochemistry and biological testing.
Intersectoral Mobility <input checked="" type="checkbox"/> Short Visit <input type="checkbox"/> Secondment	<p><i>Host: AMGEN Türkiye</i></p> <p><i>Context of Mobility: Management for the Pharmaceutical Industry</i></p>
Intersectoral Mobility <input checked="" type="checkbox"/> Short Visit <input type="checkbox"/> Secondment	<p><i>Host: Istanbul Health Industry Cluster (ISEK)</i></p> <p><i>Context of Mobility: Entrepreneurship Training, Thematic Pre-incubation Program</i></p>
International Academic Secondment	<p><i>Host Supervisor: Alexandra Alves</i></p> <p><i>Host Institution: University of Minho, Braga, Portugal</i></p> <p><i>Host Department: Mechanical Engineering</i></p>

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	<p><i>Duration: 1 year</i></p> <p><i>Estimated Time of Mobility: 2nd year</i></p>									
Main Supervisor										
Brief CV	<p>Assoc. Prof. Fatih Toptan</p> <p>E-mail: fatihoptan@iyte.edu.tr</p> <p>ACADEMIC DEGREES</p> <table> <tr> <td>Ph.D. Materials Science</td> <td>Yildiz Technical University, Turkey</td> <td>2011</td> </tr> <tr> <td>M.Sc. Materials Science</td> <td>Yildiz Technical University, Turkey</td> <td>2006</td> </tr> <tr> <td>B.Sc. Metallurgical and Materials Eng.</td> <td>Yildiz Technical University, Turkey</td> <td>2002</td> </tr> </table> <p>Google Scholar: https://scholar.google.com/citations?hl=tr&user=G1nbc4sAAAAJ https://orcid.org/0000-0001-9138-9119</p>	Ph.D. Materials Science	Yildiz Technical University, Turkey	2011	M.Sc. Materials Science	Yildiz Technical University, Turkey	2006	B.Sc. Metallurgical and Materials Eng.	Yildiz Technical University, Turkey	2002
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Brief CV	<p>Asst. Prof. Deniz Yücesoy</p> <p>E-mail: denizyucesoy@iyte.edu.tr</p> <p>ACADEMIC DEGREES</p> <table> <tr> <td>Ph.D. Materials Science and Engineering</td> <td>University of Washington, US</td> <td>2018</td> </tr> <tr> <td>M.Sc. Materials Science and Engineering</td> <td>University of Washington, US</td> <td>2014</td> </tr> <tr> <td>B.Sc. Molecular Biology & Genetics</td> <td>İzmir Institute of Technology</td> <td>2009</td> </tr> </table> <p>ResearchGate: https://www.researchgate.net/profile/Deniz-Yucesoy https://orcid.org/0000-0002-9590-3178</p>	Ph.D. Materials Science and Engineering	University of Washington, US	2018	M.Sc. Materials Science and Engineering	University of Washington, US	2014	B.Sc. Molecular Biology & Genetics	İzmir Institute of Technology	2009
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Brief CV	<p>Assoc. Prof. Duygu Ege</p> <p>E-mail: duygu.ege@boun.edu.tr</p> <p>ACADEMIC DEGREES</p> <table> <tr> <td>Ph.D. Medical Material</td> <td>University of Cambridge, UK</td> <td>2013</td> </tr> <tr> <td>M.Eng. Materials Science and Engineering</td> <td>Imperial College, UK</td> <td>2009</td> </tr> <tr> <td>B.Sc. Materials Science and Engineering</td> <td>Imperial College, UK</td> <td>2008</td> </tr> </table> <p>Google Scholar: https://scholar.google.com/citations?user=rrnTjdIAAAJ&hl https://orcid.org/0000-0002-9922-6995</p>	Ph.D. Medical Material	University of Cambridge, UK	2013	M.Eng. Materials Science and Engineering	Imperial College, UK	2009	B.Sc. Materials Science and Engineering	Imperial College, UK	2008
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