Surface coating and microstructuring for compound functionalized biomaterials in dentistry

Lukas Stepien[1 *], Franz Marquart[1], Elena Lopez[1], Mehmet Aladag[2], Izabela Zglobicka[2], Krzysztof Kurzydlowski[2], Mihaela Pricop[3], Heike Meissner[4], Torsten Sterzenbach[4], Sarah Burlein[4], Günter Lauer[4]

[1]Fraunhofer Institute for Material and Beam Technology, Dresden, Germany,
[2]Bialystok University of Technology, Faculty of Mechanical Engineering, Bialystok, Poland
[3]National University of Science and Technology Politehnica of Bucharest, Department of Applied Mathematics, Bucharest, Romania
[4]TU Dresden, Medical Faculty Carl Gustav Carus, Department of Orthodontics, Dresden, Germany

* presenting author e-mail: lukas.stepien@iws.fraunhofer.de

With the ever-increasing aesthetic demands of patients in dentistry/orthodontics, new materials and material combinations that can be used in the oral cavity are attractive. The aim of the SMILE project is to produce new functionalized metal-polymer brackets for orthodontic applications. In addition, an antimicrobial coating with anti-caries potential will functionalize the composite surface of these brackets to overcome the disadvantages of the polymer.
The production of the brackets using two widely used AM technologies, Laser Powder Bed Fusion (LPBF) and Direct Energy Deposition (DED) will be presented in the talk. The starting material for the processes is nickel-free alloy PANACEA powder. While in the LPBF-Route the whole bracket with the microstructure is printed, DED uses pre-fabricated bracket bodies' applying the microstructure. With both methods complete metallic micro structured brackets and microstructures on conventional brackets could be fabricated. Afterwards these brackets are covered with polymer (Trogamid) by injection molding. The brackets were subjected to comprehensive material testing, including destructive and non-destructive techniques. A detailed description of the geometry, microstructure and properties of both metallic bracket types was carried out. The results of the in vitro biocompatibility on various samples of the compound brackets are presented during poster session. All materials showed comparable very good biocompatibility. Two anchor polymers (hexetidine and PEG-One) were tested for their suitability as antimicrobial coatings for brackets [1]. Both resulted in significant inhibition of the growth of several caries-causing bacteria. Under simulated clinical conditions, the bond between the polymer and metal was stable and there was no change in color.
The SMILE project has developed an aesthetic orthodontic compound bracket with a stable coating and antimicrobial properties. The next step is to test these brackets in vivo.

[1] Ruland A et al. Amphiphilic copolymers for versatile, facile, and in situ tunable surface biofunctionalization. Adv. Mater. 2021, 33, 2102489

Funding organisations:

- Sächsisches Staatsministerium für Wissenschaft, Kultur und Tourismus (SMWK), Germany
- National Science Centre (NCN), Poland
- Executive Agency for Higher Education, Research, Development and Innovation Funding (UEFISCDI), Romania