The effect of surface modification on adhesive strength between 3-D printed titanium alloy and bone cement in orthopedic application

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Statement of the Problem: A properly prepared surface plays a vital role in the successful application of various biomedical solutions. In case of revision surgery, it is advisable to use the spacer as a temporary implant, usually made of metal rod covered by antibiotic-loaded bone cement, used for the local treatment of postoperative infection. One of the main limitations of spacers is their aseptic loosening, caused, i.e. by debonding effect at the metal–bone cement interface. In numerous studies it has been suggested that implant-cement fixation properties might be improved by the appropriate manufacturing method, material selection, as well as surface treatment of spacers.

The Purpose of this study: In this study the effect of the surface treatment of Ti13Zr13Nb specimens produced by selective laser melting (SLM) on bone cement coating adhesion was evaluated.

Methodology & Theoretical Orientation: Ti13Zr13Nb alloy specimens were manufactured by selective laser melting (SLM) method and subjected to the following surface treatments: sandblasting, grinding and etching. Subsequently, the printed specimens were covered by bone cement. For each condition, the surface evaluation of titanium alloy specimens, as well as the assessment of cement adhesion to the surface, was carried out. The results of each test were compared to the two control groups, consisting of commercially available Ti13Zr13Nb and untreated SLM-made specimens.

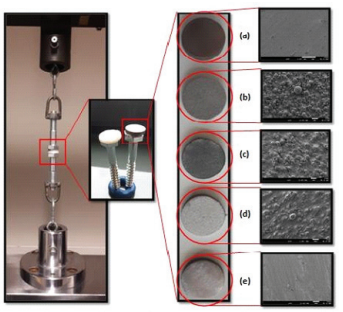

Figure 1: Adhesion strength test and titanium alloy specimens with SEM images (x100) after different surface treatments (a) Solid bar; (b) Untreated selective laser melting (SLM); (c) Sandblasted SLM; (d) Etched SLM; and, (e) Ground SLM

Conclusion & Significance: Surface treatment and method of fabrication of titanium affected surface parameters that had a significant impact on cement-titanium fixation. The highest adhesion bone cement to the titanium alloy was obtained for specimens with high nanohardness and roughness. Sandblasting or etching were the best alloys treatments in terms of the adhesion. Overall, the higher adhesion strength of bone cement coating to the SLM specimens is a good precondition for the SLM application in the production of metal-polymer implants for tissues with heavy loads.

Biography

Magda Dziaduszewska, PhD student and research assistant at the Gdansk University of Technology, Department of Materials Engineering and Bonding, Biomaterials Division. Her main interests are connected with development and surface modification of porous titanium structures for orthopedic applications, including selective laser melting manufacturing of scaffolds or titanium implants with the porous surface layer, surface modification as well as the development of bioactive and biocompatible coatings.

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