Karlsruhe Institute of Technology

Institute for Applied Materials

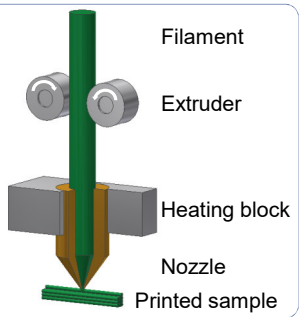
Zirconia for dental implants

Dorit Nötzel[1], Ralf Eickhoff[1], Mark Scholz[1], Thomas Hanemann[1,2]
[1]Karlsruhe Institute of Technology, Institute of Applied Materials, Eggenstein-Leopoldshafen, Germany
[2]Laboratory for Material Processing, Department of Microsystems Engineering – IMTEK, University of Freiburg, Freiburg, Germany

Motivation

Zirconia (ZrO_2) as material for dental implants becomes more and more popular because of allergic and aesthetic issues. Commonly used 3Y-doted zirconia has got excellent mechanical properties, the translucent optic of 5Y-zirconia looks more tooth-like.

3D-printing as a toolless manufacturing method offers an unsuspected freedom of design. Fused Filament Fabrication (FFF) is a technology of additive manufacturing (AM) that is characterized by cost-effective and nearly maintenance free devices. 3D-printers with open software offer an enormous freedom of processable materials. By using more than one print head, different materials can be printed in one component. We want to combine the design freedom with our experience in material development.

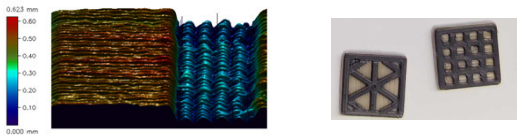


Schema of FFF

Surface texturing

Even though zirconia shows an outstanding biocompatibility, bone growing-in times are longer than with conventional titanium materials. It is established, that texturing of surfaces can lead to better cell adhesion.

FFF shows native procedural structures due to the layered structure of AM. These structures could be improved by adapting the printing properties. Additional textures at the surface can be implemented by FFF as well.

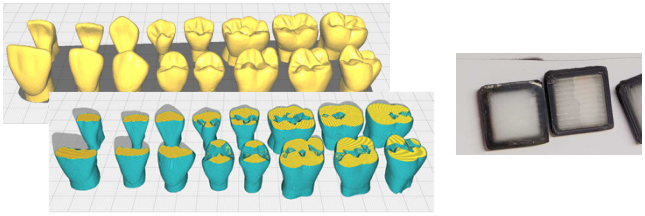


Left: white light interferometry of side surface, right: textured top surface with white and black zirconia

Surface „coating“ of visible dentures

Commonly used 3Y-doted zirconia shows excellent mechanical properties, but the translucent optic of 5Y-zirconia looks more tooth-like. Fabrication of dental prosthetics from 3Y-ZrO_2 with a thin surface of 5Y-ZrO_2 could combine both advantages.

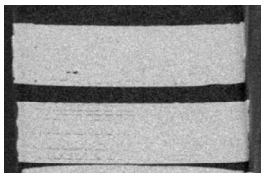
The outlines of the dental prosthetics can be printed using a second extruder filled with a more translucent material in one procedure.



Left: tool path generation of specimen with material of infill ≠ outline, right: printed and sintered samples of white and black zirconia

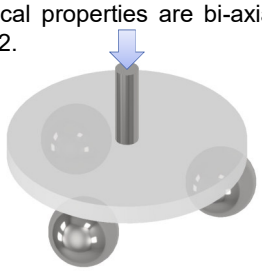
Evaluation

To characterize and evaluate the properties of printed and sintered dental prosthetics we use computer tomography to display the inner structure like voids and delamination of layers that weakens the mechanical properties.



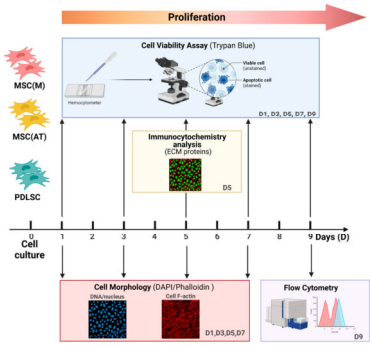
CT image of printed and sintered alumina

Mechanical properties are bi-axial tested according to DIN EN ISO 6872.



Schema of biaxial testing

For biological characterisation cell coverage, adhesion, proliferation and differentiation marker can be measured.



Example of biological testing
Source: DOI: 10.3390/ Biomedicines11051352

dorit.noetzel@kit.edu
MSE 2023 in Geesthacht