SURFACE COATING AND MICROSTRUCTURING FOR COMPOUND FUNCTIONALIZED BIOMATERIALS IN DENTISTRY - SMILE

M-ERA.NET

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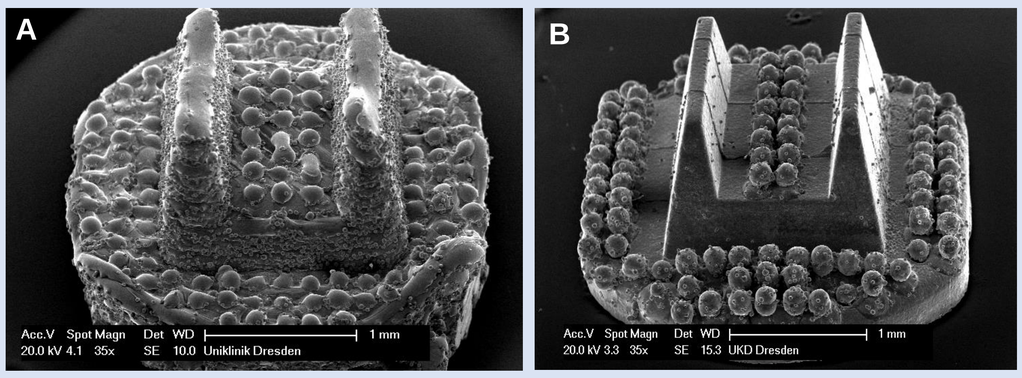
BACKGROUND

As patients' aesthetic demands in orthodontics continue to increase, new materials and material combinations that can be used in the oral cavity are attractive. One challenge is that the properties of combined materials can be altered and their adhesion impaired due to the oral environment.

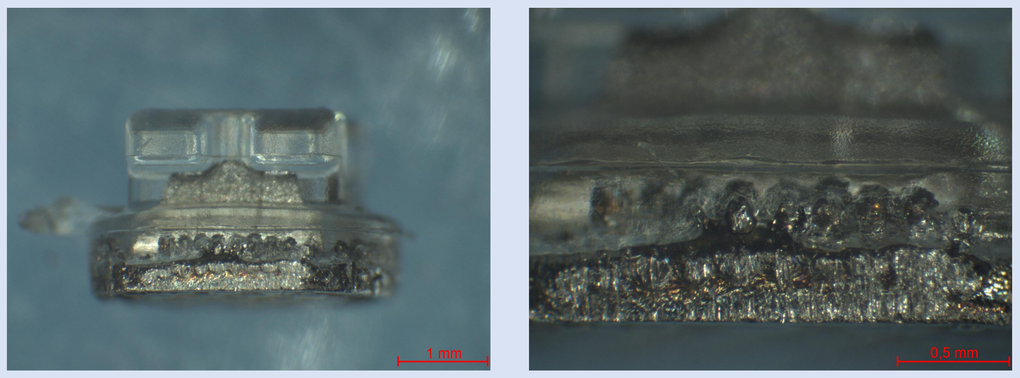
THE AIM OF THE SMILE PROJECT was to produce new functionalized metal-polymer brackets for orthodontic applications. In addition, an antimicrobial coating with anti-caries potential will functionalize the composite surface of these brackets to overcome the disadvantages of the polymer.

KEY FINDINGS

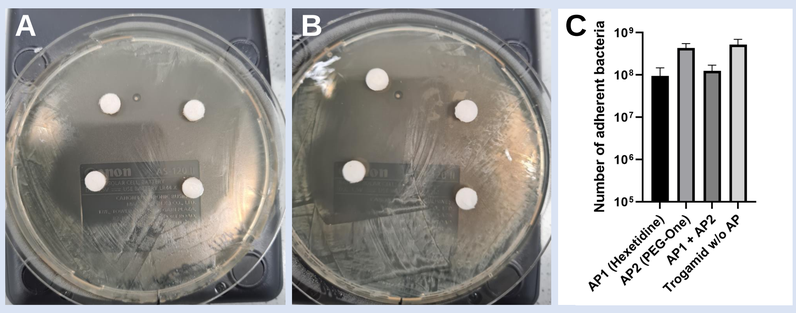
With the AM technologies, Laser Powder Bed Fusion (LPBF) and Direct Energy Deposition (DED), complete metallic micro structured brackets (A) and microstructures on conventional brackets could be fabricated (B).



The brackets were covered with polymer (Trogamid) by injection molding. The coating of the brackets was almost complete, at around 98%. Only the bracket base showed minor coating defects, which can be neglected.



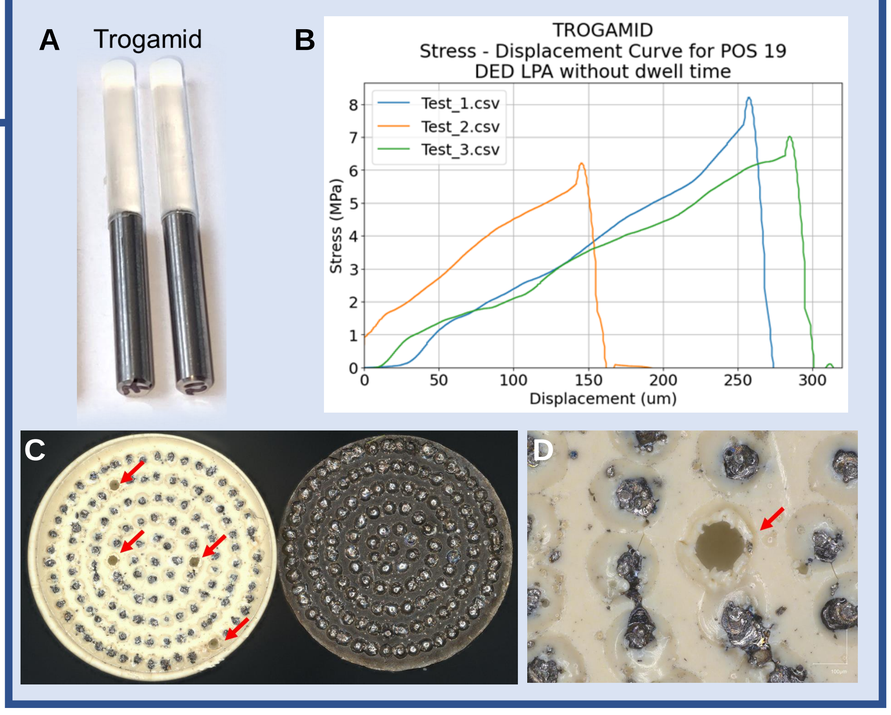
Two different anchor polymers alone [Hexetidine (A) and PEG-One (B)] or a mixture of both resulted in significant inhibition of the growth of several caries-causing bacteria (C).



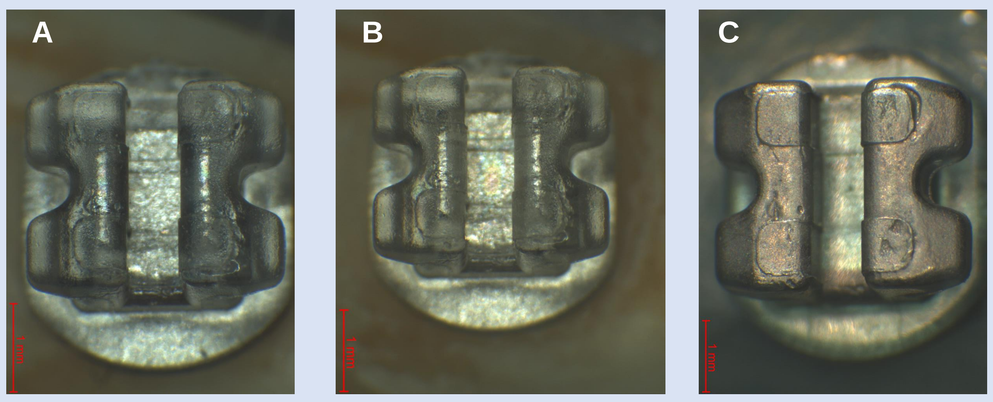
Bacteria strain	Anchor polymer	Size of inhibition zone (mm) at different concentrations of anchor polymer			
		1 mg/ml	0,5 mg/ml	0,25 mg/ml	0,125 mg/ml
S. mutans	PEG-One	2	1,6	1,2	0,4
S. mutans	Hexetidine	1.5	1.5	1.1	0.8
S. mutans	Mix	2	1.6	1.2	0.4
L. plantarum	PEG-One	1.4	0.9	0	0
L. plantarum	Hexetidine	1,1	0,9	0	0
L. plantarum	Mix	1.1	0.9	0	0
A. naeslundii	PEG-One	>3	>3	>3	1
A. naeslundii	Hexetidine	>3	>3	1.3	1.3
A. naeslundii	Mix	>3	>3	1	1
S. aureus	PEG-One	2	1.7	1.1	0.7
S. aureus	Hexetidine	2	1.6	1.2	1
S. aureus	Mix	2	1.8	1.5	1.1

THE SMILE PROJECT HAS DEVELOPED AN AESTHETIC ORTHODONTIC COMPOUND BRACKET WITH A STABLE COATING AND ANTIMICROBIAL PROPERTIES.

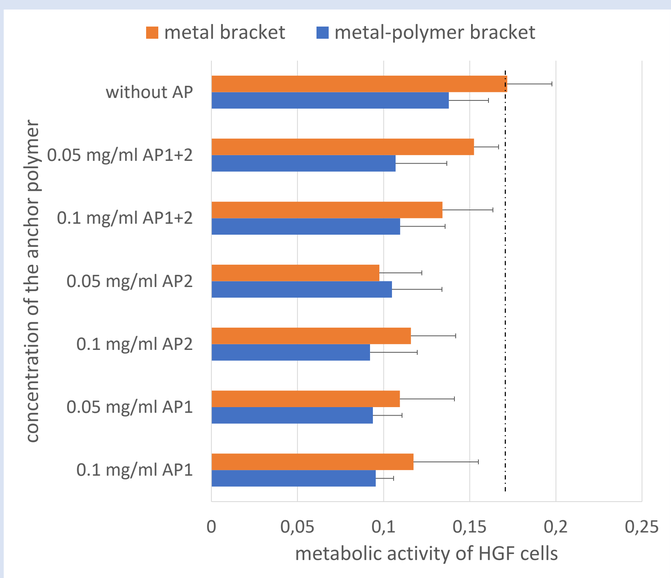
The tensile test of pinned tubes (A) showed mean stress values of 4.9 ± 1.4 MPa with dwell time and 7.1 ±1.0 MPa without dwell time (B). During the separation, the interlocking pins were detached from each other. In the process, the metallic microstructure of the brackets was destroyed, but not the contact between the polymer and the metal (C+D).



No damage to the Trogamid coating was observed under simulated clinical conditions [simulated ageing processes (B) and repeated cleaning with toothbrushes (C)] compared to the initial state of the polymer-metal brackets (A).



Both pure metal and Trogamid brackets, as well as metal-polymer brackets, show very good in vitro biocompatibility. When the brackets are coated with the various anchor polymers, there is a slight increase in cytotoxicity of about 30%.



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