ZrN (zirconia nitrite) Features and Benefits

Features	Benefits	Scientific Evidence
Six times stronger than titanium	Will not scratch as easily when cleaned using curettes, ultrasound or other instruments.	
Biofilm will not form as easily on the surface	With less biofilm and plaque there will be less quantity and quality of bacteria that can cause inflammation in the soft tissue.	
Surface is more resistant to corrosion	Dental plaque produce acid that will corrode the surface and increase the roughness. ZrN is harder and has a smaller friction coeffecient and will and together with the less bacterial biofilm be more resistent to corrosion	
Increased adhesion of fibroblasts	A higher adhesion of fibroblasts creates locks the path between the surface and soft tissue preventing bacteria to enter the gingival margin.	
Increased collagen stability	ZrN creates less of an inflammatory burdon and collagen degradation in the gingival tissue as evidenced by less aMMP8 biomarker in the gingival fluid.	
ZrN has a warm gold hue	A warmer goldish hue has esthetic advantages compared to the grey titanium, especially in the esthetic zone	
All ZrN features supports *Periimplant Health* and lifetime extension of the implant treatment		

aMMP-8 as an immunological biomarker for Peri-implant infections

Article

Correlation between Peri-Implant Marginal Bone Loss Progression and Peri-Implant Sulcular Fluid Levels of Metalloproteinase-8

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Abstract: Objectives: The aim of this retrospective study was to analyze peri-implant marginal bone loss levels/rates and peri-implant sulcular fluid levels/rates of metalloproteinase-8 in three timeframes (6 months post-surgery—restoration delivery (T0)—and 6 (T6) and 24 (T24)-months post-loading) and to evaluate if there is a correlation between peri-implant sulcular fluid levels of metalloproteinase-8 and peri-implant marginal bone loss progression. Materials and Methods: Two cohorts of patients undergoing implant surgery between January 2017 and January 2019 were selected in this retrospective study. A total of 39 patients received 39 implants with a laser-microtextured collar surface, and 41 subjects received 41 implants with a machined/smooth surface. For each patient, periapical radiographs and a software package were used to measure marginal bone loss rates. Implant fluid samples were analyzed by an enzyme-linked immunosorbent assay (ELISA) test. The modified plaque index, probing depth, and bleeding on probing were also recorded. Results: High marginal bone rates at T24 were strongly associated with elevated rates between T0 and T6. The levels of metalloproteinase-8 were significantly more elevated around implants with marginal bone loss, in relation to implants without marginal bone loss. Marginal bone loss (MBL) rates at 24 months were associated with initial bone loss rates and initial levels of metalloproteinase-8. Conclusions: Peri-implant marginal bone loss progression is statistically correlated to peri-implant sulcular fluid levels of metalloproteinase-8. Moreover, the initial high levels of marginal bone loss and metalloproteinase-8 can be considered as indicators of the subsequent progression of peri-implant MBL: implants with increased marginal bone loss rates and metalloproteinase-8 levels at 6 months after loading are likely to achieve additional marginal bone loss values.

Keywords: dental implant; marginal bone loss; metalloproteinase-8; sulcular fluid

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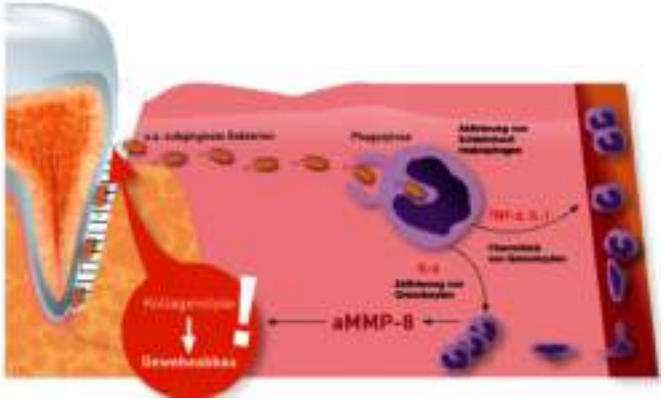


Claim 1

Less formation of Biofilm on ZrN surface

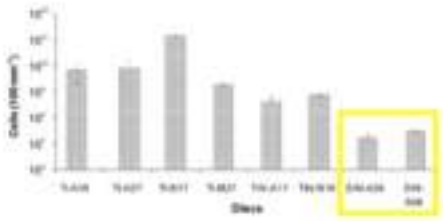
Comparision of surface effects on plaque adhesion and development

Größner-Schreiber B, Hannig M, Griepentrog M, Wenderoth DF (2004)

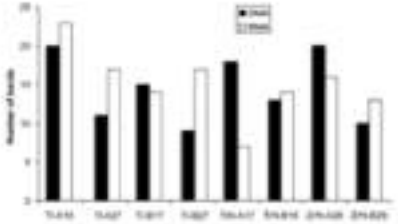
Background:
> Osseointegrated dental implants play an important role in restorative dentistry.
> Plaque accumulation may cause inflammatory reactions around the implants, sometimes leading to implant failure

In vivo study:
> Influence of two physical hard coatings on bacterial adhesion was examined in comparsion with a pure titanium surface
> Thin glass sheets coated with titanium nitride (TiN), zirconium nitride (ZrN) or pure titanium were mounted on removable intraoral splints in two adults
> After 60 h of intraoral exposure, the biofilms were analyzed to determine the number of bacteria, the types of bacteria, and whether or not the bacteria were active

Result:
> Bacterial cell counts were higher on the pure titanium-coated glass sheets than on the glass sheets coated with TiN or ZrN.
> The lowest number of bacterial cells was present on the ZrN-coated glass.
> The metabolic activity of bacteria on TiN- and ZrN-coated glass sheets seemed to be lower than the activity of bacteria on the titanium-coated surfaces



Bacterial cell counts of the biofilms grown on discs with different coatings. (Ti: titanium; TiN: titanium nitride; ZrN: zirconium nitride)



Specific number of bands obtained from polymerase chain reaction (PCR) and reverse transcription (RT)-PCR single-strand conformation polymorphism (SSCP) fingerprints from bacterial biofilm communities (all bands with more than 2% relative abundance)

In the oral cavity of humans there are less bacterial cell counts on ZrN than on titanium.

Claim 2

Increased adhesion of Fibroblasts to ZrN

Focal adhesion contact formation by fibroblasts cultured on surface-modified dental implants: an in vitro study

Größner-Schreiber B, Herzog M, Hedderich J, Dück A, Hannig M, Griepentrog M (2006)

Background:

> A major consideration in designing dental implants is to create a surface that provides strong attachment of the implant to bone, connective tissue and ephitelium.

> Aim of the present study was to examine the influence of different treatments of titanium (Ti) implant surfaces on focal adhesion contact (FAC) formation in fibroblast cultures

In vitro study:

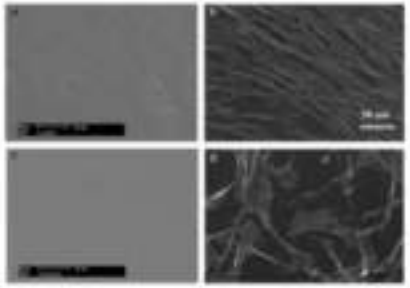
> Human gingival fibroblasts were cultured on glass sheets and polished Ti discs with different surface coatings (applied by PVD): Ti, titanium nitride, zirconium nitride or on Ti discs with different surface topographies

Result:

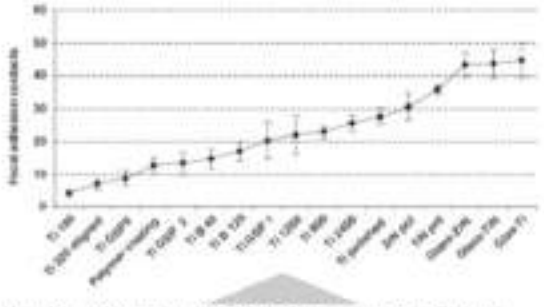
> Strong correlation between the number of FACs and the surface roughness

> Highest number of FACs and the majority of the immunogold-labeled intra- and extracellular matrix molecules were counted on surfaces with the lowest surface roughness: glass sheets coated with either Ti, TiN or ZrN (roughness average=0,003-0,1 µm).
These surfaces appear to favor cellular attachment of human gingival fibroblast and moreover in previous studies the hard coatings have been shown to reduce bacterial

Zirconium nitride favors the cellular attachment of gingival fibroblasts



Scanning electron micrographs of surface-modified titanium (Ti) discs with and without fibroblasts: [a,b] polished titanium, [c,d] zirconium nitride-coated polished Ti Magnification: a,c x 400; b,d x 297



Number of focal adhesion contacts on distance of 300µm (transmission electron microscopy). The horizontal bars indicate homogenous subgroups based on the Scheffé multiple comparison procedure.

Claim 3

Increased Collagen stability on ZrN

Matrix-Metalloproteinase-8 Levels in PISF of Titanium and Zirconianitrid abutments Meissen R, Mintcheva M, Netuschil L (2012)

Background:

> Provoking an inflammatory host interaction the oral bacterial biofilm is the main cause of periodontitis and periimplantitis. It triggers an immunologival reaction of the host.

> During the host interaction against the oral biofilm matrix-metalloproteinase-8 (aMMP-8) is activated leading to collagenolytic destruction of host tissues.

> In peri-implantitis the active form of aMMP-8 is elevated in peri-implant sulcus fluid (PISF)

Examination:

> The biomarker MMP-8 in PISF from titanium abutments and those coated with zirconium nitride (ZrN) was compared in vivo in a split mouth design in 60 patients at 6 weeks, 6 months, 12 months after prosthetic restoration

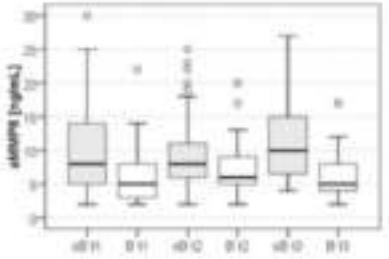
Result:

> To different times after prosthetic restoration ZrN-coated abutments showed unequivocally significant lower aMMP-8 values in their PISF which are compatible with a healthy tissue compared to Ti abutments

> Exp: mean aMMP-8 values reached 10-12 ng/ml in case of titanium, and only 6,6-7,5 ng/ml with ZrN

Clinical picture one year after prosthetic restoration with zirconium nitride coated abutments

Clinical picture one year after prosthetic restoration with titanium abutments



Box-Whiskerplot of aMMP-8 values from peri-implant sulcular fluid (PISF) of titanium abutments (oB) and zirconium nitride coated abutments (B) at different time points (t1: 6 weeks; t2: 6 months; t3: 12 months after prosthetic restoration

ZrN coated abutments exert a beneficial effect concerning biofilm formation in vitro and collagenolytic tissue destruction driven by aMMP-8 in situ

Claim 4

ZrN surface is 6x harder than TiO

ZrN is extremely wear resistant, insoluble in water and its melting point is nearly 3000°C. It is not resistant against hydrogen peroxide. The hardness and wear resistance of both pure titanium gr. 4 and titanium gr. 4 coated with zirconium nitride has been tested (see Tab. 13). The average friction coefficient is a measure for the wear resistance of materials. The lower the average friction coefficient, the higher is the wear resistance.

Comparison of pure titanium and zirconium nitride

	Pure Titanium gr. 4	Zirconium Nitride
Test report	051207, MAT PlasMATec GmbH Dresden, Germany, attachment A.26	071023, MAT PlasMATec GmbH Dresden, Germany, attachment A.27
Hardness	373.9 HV	2232 HV
Av. Friction Coefficient	0.34	0.22

A.26 MAT PlasMATec GmbH Dresden Germany, Test Report Titanium Specimen, No.: 051207, 2007
A.27 MAT PlasMATec GbmH Dresden Germany, Test Report Zirconium Nitride Coating, No.: 071023, 2007

Claim 5

ZrN is more corrosion resistant and more biocompatible

Biokompatibilität von ZrN beschichteten Dentalimplantat-Oberflächen verglichen mit bearbeiteten Reintitan-Oberflächen

Becker J (2008)

Background:

> On all prosthtic superconstructions of oral implants there are interactions of the surfaces with microorganisms of the oral environment after insertion in the oral cavity within a short period of time biofilms can develop on all surfaces, which are one of the main reasons of peri-implantitis

> Objective: Examination of changes of different titanium surfaces due to biofilm and resulting changes of the surface biocompatibility

Examined titanium surfaces:

> Titanium with sputtered zirconium nitride coating (ZrN), titanium with anodosed gold-colored titanium oxide coating (TO), tanium with zirconium nitride coating „dentin-yellowgold" (ZN MAT)

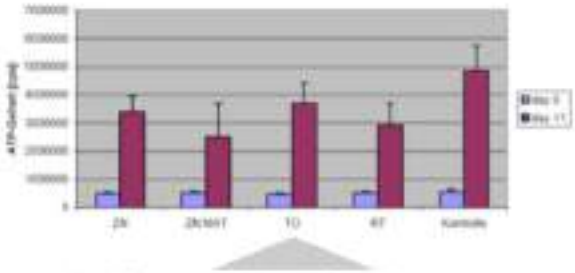
> Titanium with polished pure titanium grade 4 (RT)

Behavior of the different surfaces after removal of biofilm (Laser, tooth brush):

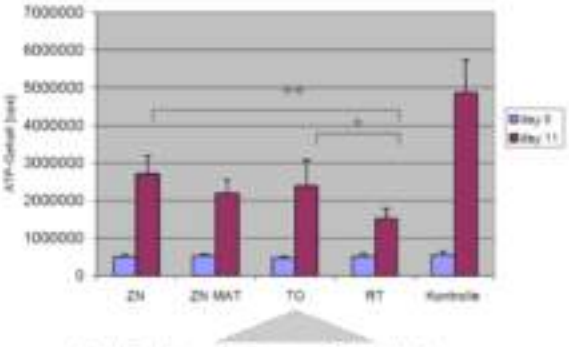
> Highest cell profileration on ZrN surface (followed by TO, ZN MAT, RT)

> Adhesion of gingival fibroblasts on surface cleaned from plaque: highest at ZrN

Compared to other surfaces ZrN shows a highly significant better biocompatibility for the adhesion of gingival fibroblasts after removal of biofilm



Proliferation of gingival fibroblast on differetn surfaces at day 0 & 11. (mean values & standard deviation)



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