Implant Surface Enhancement - Myth and Reality
Comparative analysis of currently available implants

Dr. M. Gross [1], R. Jansen [2], Dr. P. Gehrke [3], P. Cantzler [4]

Germany: [1,2] Schwetzingen, [3,4] Mannheim

Introduction

Implant surface characteristics are considered to play a mayor role in accelerating the processes leading to osseointegration. Some manufacturers claim for a reduced healing time (6-8 or 8 weeks)[7]. Besides physical and chemical parameters like wettability, positive or negative surface charge and surface-free energy, the topography of dental implant surfaces can influence cell attachment und subsequent osseointegration. [3-5] Several cell types are involved in the process of osseointegration, osteoblast-like cells and other anchorage-dependent cells, such as fibroblasts.These cells show similar morphologic behaviour and affinity to rough titanium surfaces.[2]

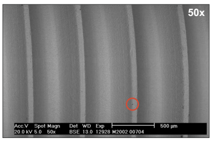
The aim of this poster is to present the topographical aspects of currently available implant surfaces.

Material and Methods

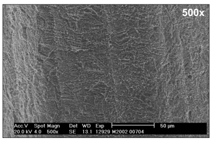
Different commercially available dental implants have been investigated to compare surface roughness and reproducibility of advertised properties. Scanning electron microscopy (SEM) was used for topographical evaluation, backscattered electron imaging (BEI) was used for density and/or atomic number analysis, and x-ray micro-analysis (XRM) was used for elemental analysis.

Results

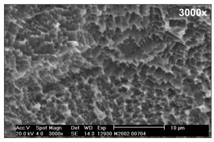
3i Osseotite® (Solely acid-etched)



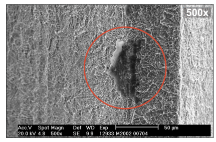
Embedded particles on threads



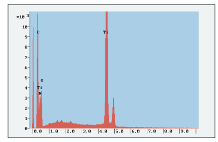
Topography of solely acid-etched surface



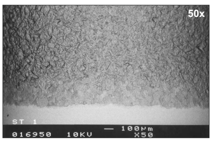
Slightly inhomogeneous surface structures



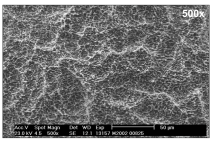
Embedded particle; magnification 500x


XRM-analysis of embedded particle. Possible source: sealing cap used for protection while etching

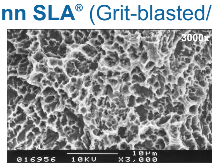
Straumann SLA® (Grit-blasted/acid-etched)



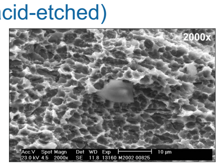
Surface of grit-blasted and acid etched implant



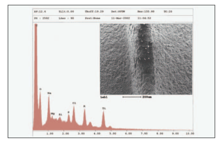
Topography of grit-blasted and acid-etched surface



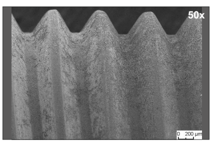
Homogeneous topography of grit-blasted and acid-etched surface



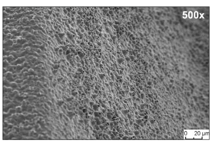
Grit particle on surface; magnification 2000x


XRM-analysis of small particles on thread; source: organic material

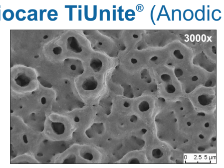
Nobel Biocare TiUnite® (Anodic oxidation)



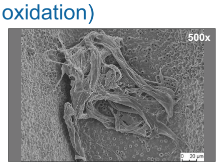
Inhomogeneous surface morphology, produced by anodic oxidation



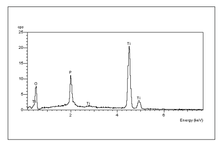
Topography of surface produced by anodic oxidation; porous structures



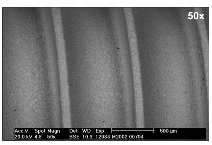
Cracked surface and highly inhomogeneous distribution of porous structures



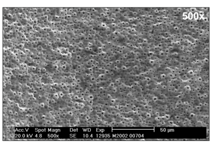
Foreign fibrous particle on surface; magnification 500x


XRM-analysis of surface; high concentration of phosphorus (claimed as pure TiO2-surface)

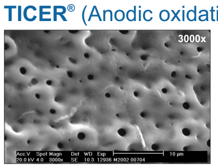
ZL TICER® (Anodic oxidation)



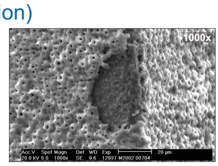
Inhomogeneous porosities on threads



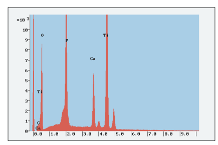
Topography of surface produced by anodic oxidation; similarity to TiUnite surface



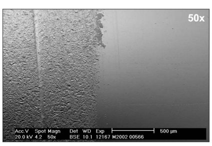
Cracked surface and inhomogeneous distribution of porosities



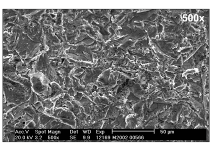
Surface defect; magnification 1000x


XRM-analysis showing presence of calcium and phosphorus

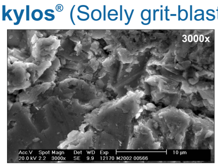
Ankylos® (Solely grit-blasted)



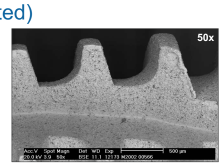
Embedded particle on transition area



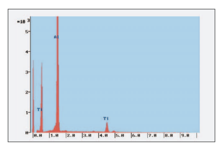
Structure of solely grit-blasted surface



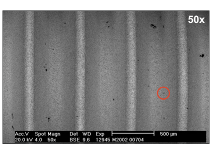
Structure with presence of grit particles



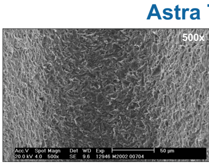
Surface defect on threads; magnification 50x


XRM-analysis of grit particle; identified as aluminium oxide

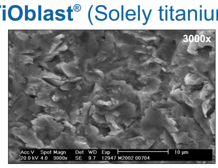
Astra TiOblast® (Solely titanium-blasted)



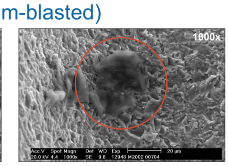
Embedded particles on surface



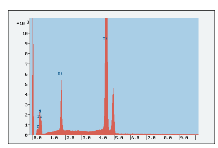
Structure of titanium-blasted surface



Slightly inhomogeneous blasted surface



Embedded particle; magnification 1000x


XRM-analysis of embedded particle; source: organic material

Conclusion

Some marketing claims on implant surface characteristics should be critically evaluated and discussed on their clinical evidence. Embedded particles of the production process like grit particles can be observed as well as inhomogeneous structures.[1] Nevertheless, within the range of state-of-the-art implant surfaces very high success rates have been documented.[6] Topographical similarities of different implant surfaces can be observed. This could lead to the conclusion that reduced healing times claimed for a specific surface could also be related to surfaces with similar topographies. Surface roughness values are not clearly related to topographical appearance. Further development of enhanced implant surfaces should lead to morphologic structures which are homogeneously distributed to enable an allover high level of close cell attachment. Limited data on the influence of embedded production particles on the implant surface is available. However, Paolantonio et al. has demonstrated that no statistic evidence could be provided to support the hypothesis that surface inorganic contamination could affect osseointegration of titanium dental fixtures.[8]

References

1. *Ricci JL, Kummer FJ, Alexander H, Casar RS:* Embedded Particulate Contaminants in Textured Metal Implant Surfaces (Technical Note). J Applied Biomater 3(3):225-230
2. *Lumbikanonda N, Sammons R:* Bone Cell Attachment to Dental Implants of Different Surface Characteristics. Int J Oral Maxillofac Implants 2001;16, Number 5: 627-636
3. *Kieswetter K, Schwartz Z, Dean DD, Boyan BD:* The role of implant surface characteristics in the healing of bone. CRC Crit Rev Oral Biol Med 1996;7:329-345
4. *Sykaras N, Iacopino AM, Marker VA, Triplett RG, Woody RD:* Implant materials, design, and surface topographies: Their effect on Osseointegration. A literature review. Int J Oral Maxillofac Implants 2000 ;15:625-690
5. *Brunette DM:* The effects of implant surface topography on the behaviour of cells. Int J Oral Maxillofac Implants 1988 ;3:231-246
6. OSSEOTITE Long Term Performance in Posterior Maxillary and Mandibular Cases (Compendium 1999 7:628-640)
7. *Simpson JP, Buser D, ten Bruggenkate CM, Weingart D, Taylor TM, Cochran DL, Bernard JP, Peters F:* The use of shortened healing times on ITI implants with an SLA surface. Early results from clinical trials; in preparation
8. *Paolantonio M, Vienale C, Piattelli M, Mangano C, Scarano A (University of Chieti, Italy):* Effects of surface inorganic contamination on the osseointegration of dental implants. J Dent Res. 2000 ;79 :abst 3335

European Association for Osseointegration
Brussels, Belgium
September 12-14, 2002

Awarded second prize for the poster contribution
European Association for Osseointegration
Brussels, Belgium / September 12-14, 2002