Topographical Aspects of Distinctive Titanium Surfaces - Comparative Analysis of Available Implant Surfaces

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Introduction

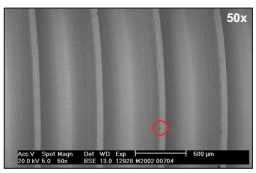
Implant surface characteristics are considered to play a mayor role in accelerating osseo-integration. distinctive surface modifications are offered by implant manufacturers recommending a reduced healing time of 6 to 8 weeks [7]. Besides physical and chemical parameters like wettability, positive or negative surface charge and surface-free energy, the topography of dental implant surfaces can influence cell attachment und subsequent osseointegration.[3-5] Osteoblast-like or other anchorage-dependent cells, e.g. fibroblasts, show similar morphologic behaviour and their affinity to rough titanium surfaces.[2]
The topographical aspects of currently available implant surfaces and their serial reproducibility are compared.

Material and Methods

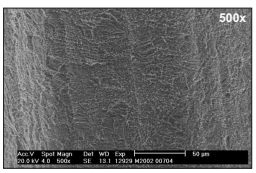
Different commercially available dental implants have been investigated by scanning electron microscopy (SEM) to compare surface roughness and reproducibility of the properties advertised. Backscattered electron imaging (BEI) was used for density and/or atomic number analysis, and x-ray microanalysis (XRM) was used for elemental analysis. The results of differently engineered implant surfaces will be compared and discussed for: solely etched, solely blasted and grit-blasted/ acid-etched treatments.

Results

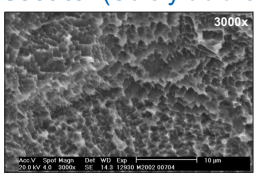
3i Osseotite® (Solely acid-etched)



Embedded particles on threads

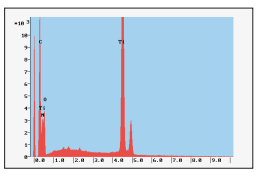


Topography of solely acid-etched surface

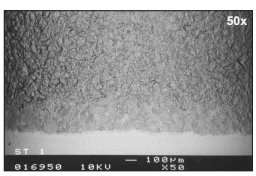


Slightly inhomogeneous surface structures

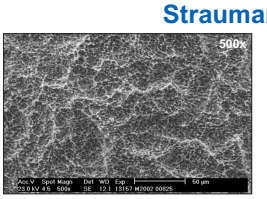
Embedded particle; magnification 500x


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

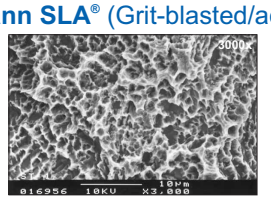
Straumann SLA® (Grit-blasted/acid-etched)



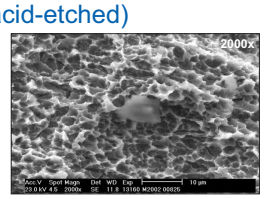
Surface of grit-blasted and acid etched implant



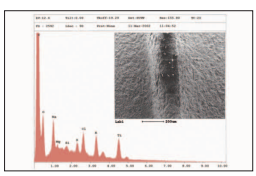
Topography of grit-blasted and acid-etched surface



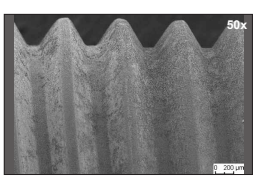
Homogeneous topography of grit-blasted and acid-etched surface



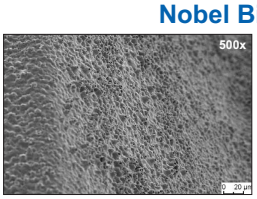
Grit particle on surface; magnification 2000x


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

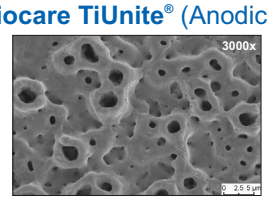
Nobel Biocare TiUnite® (Anodic oxidation)



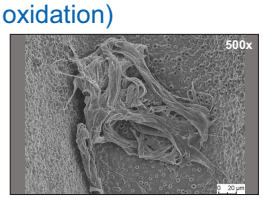
Inhomogeneous surface morphology, produced by anodic oxidation



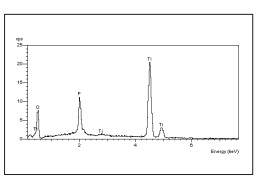
Topography of surface produced by anodic oxidation; porous structures



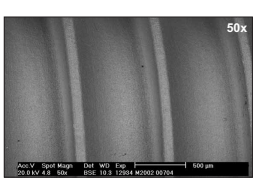
Cracked surface and highly inhomogeneous distribution of porous structures



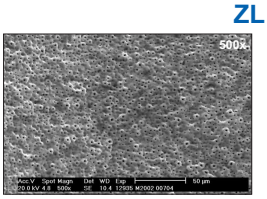
Foreign fibrous particle on surface; magnification 500x


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

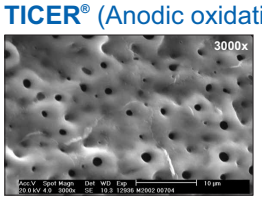
ZL TICER® (Anodic oxidation)



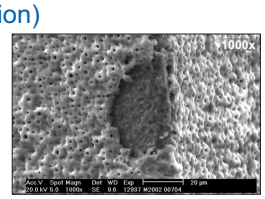
Inhomogeneous porosities on threads



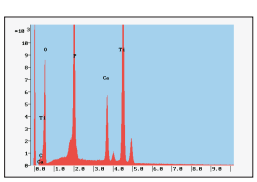
Topography of surface produced by anodic oxidation; similarity to TiUnite surface



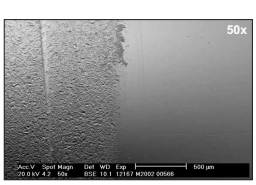
Cracked surface and inhomogeneous distribution of porosities



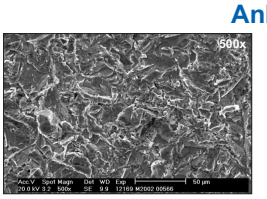
Surface defect; magnification 1000x


XRM-analysis showing presence of calcium and phosphorus

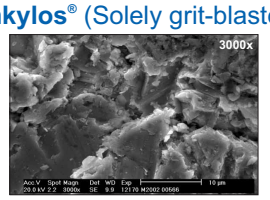
Ankylos® (Solely grit-blasted)



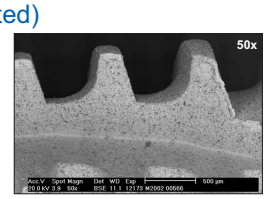
Embedded particle on transition area



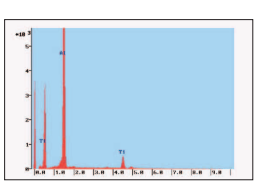
Structure of solely grit-blasted surface



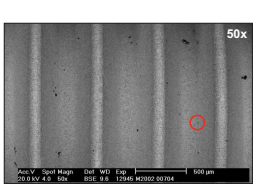
Structure with presence of grit particles



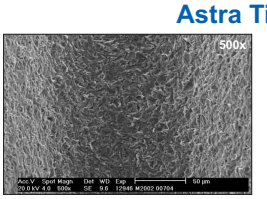
Surface defect on threads; magnification 50x


XRM-analysis of grit particle; identified as aluminium oxide

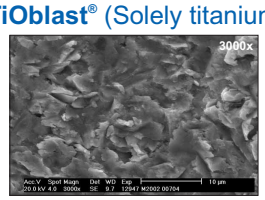
Astra TiOblast® (Solely titanium-blasted)



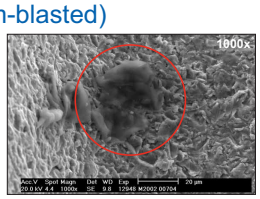
Embedded particles on surface



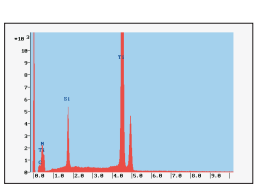
Structure of titanium-blasted surface



Slightly inhomogeneous blasted surface



Embedded particle; magnification 1000x


XRM-analysis of embedded particle; source: organic material

Conclusion

Discrepancies can be noted between the surface properties advertised by implant manufacturers and the actual appearance of the surface morphology. 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, Piattelli 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

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