

Nanocrystalline diamond coated orthopaedic titanium implants

Next generation of orthopaedic implants

- Nanocrystalline diamond coatings for hip, knee, shoulder and other orthopaedic implants possess extraordinary properties:
 - Nano-structures increase the area of titanium or ceramic surfaces for better cell-interaction, osseointegration or soft tissue attachment
 - Excellent biocompatibility (pure carbon)
 - Chemical inertness and high corrosion resistance
 - Entire passivation of metal substrate, no diffusion of metal ions
 - Brilliant tribological behaviour, Coefficient of friction < 0,05
 - High mechanical strength, perfect wear resistance
- Customized implant surface (hydrophilic (OH-groups), functionalization/protein adhesion, surface roughness, antibacterial)
- Industrial production of quality controlled NCD-coating as medical device
- Pre-clinical studies completed, first in-patient trial ongoing

Summary

Hip Joint or knee replacements are becoming common place these days. Not only older but also younger, more active patients are getting hips or knees replaced directly involved with an anticipated higher number of revision surgeries. There are four major reasons for implant failure that require revision surgery: i) aseptic (without infection) loosening, ii) hip instability (partial or complete dislocation), ii) bone loss (osteolysis) around the implant, and iv) periprosthetic (around the implant) infection. Due to the aging of the society, the prevalence of osteoporosis has increased.

Furthermore the incidence of medical therapies such as radiotherapy, chemotherapy, impairs the quality of bone. NCD-coated implants aim to solve these obstacles and DiaCoating is convinced that tailored NCD surfaces may rapidly find its way into common clinical use.

Features

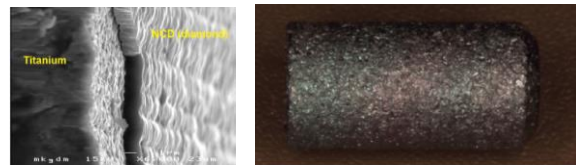
- Improved osseointegration and cell adhesion
- Corrosion resistance
- High wear resistance
- Passivation of metal surface, no diffusion or release of metal ions
- Excellent tribological surface
- Multi component system with tunable surface properties – according to patients' requirements

Advantages

- Improved cell adhesion (osseointegration) and implant integration due to increase of surface by tunable nano structures
- Excellent biocompatibility (pure carbon) and strong passivation of metal surface
- High wear resistance and low friction surface
- Brilliant corrosion resistance
- Improved hydrophilicity or controlled surface energy
- Long-term stability – reduction of follow-on surgery

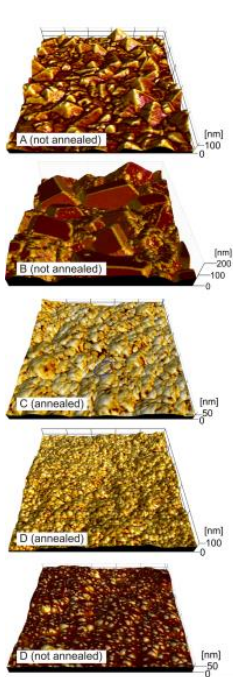
Applications

- NCD-coating of *orthopaedic implants* to improve osseointegration, increase mechanical stability (hardness, wear resistance), reduced corrosion or release of metal ions:



NCD-coating on titanium surface providing a hard, wear/corrosion resistant, nano-structured, hydrophilic surface area.

- Tunable nano-structures

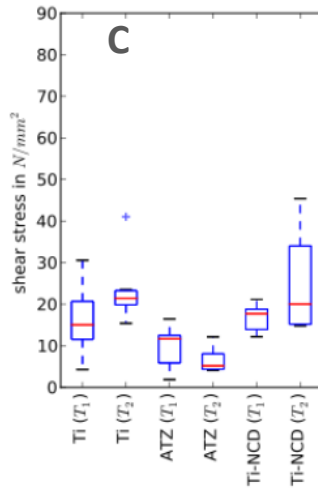


Tailored surface morphology, grain size between 5 nm and 2 μm tuneable due to required application.

Push-out tests - excellent osseointegration:



A: push-out set-up, B: no delamination of NCD

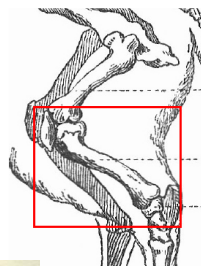


C: NCD-surfaces showed higher osseointegration than bare substrates.

Results of in vivo tests

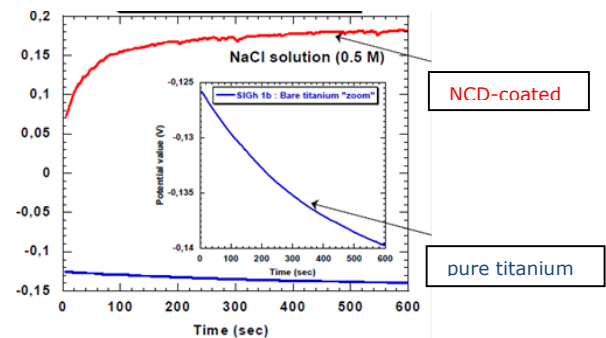
Up to now DiaCoating has carried out many *in vivo* studies and demonstrated the excellent performance and advantage of the NCD-coating in comparison to titanium and zirconia surfaces:

- 12 sheep in total
- observation periods: 1M - 3M - 6M
- 4 sheep per observation period
- 192 implants in total
- monocortical insertion



New bone formation in the marrow space, good osseointegration

corrosion resistance:



Open circuit potential measurements (scan rate: 100mV/s, 12 hours): NCD-coated titanium (red line) in NaCl solution: no corrosion, titanium surface: corrosion. (blue line).

Business model:

The technology and application of NCD on implants is patented by DiaCoating. We want to out license the technology to a strategic partner in the field of orthopaedic implantology. We offer the NCD coatings for our partner or provide him with the deposition technology/equipment to produce the coating under his own control.

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