

# Detailed Failure Analysis of Dental Titanium Implants

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## Aim of the investigation

The lifetime of a dental implant is determined by »external factors« which describe the loads the implant is exposed to, and by implant - specific properties (e.g. geometrical design, surface treatment, in rare cases material defects). Aim of our study is to elucidate the cause of implant failures by failure analysis and - if possible - to derive recommendations how to avoid these failures.

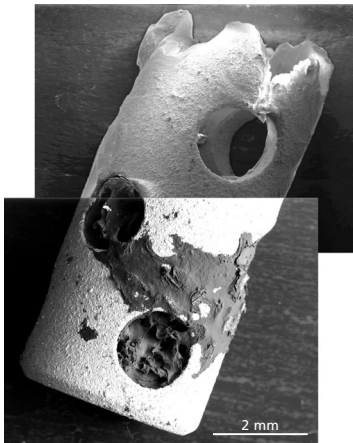
## Method and Materials

The surfaces and the fracture surfaces of several explants which were provided by the »Bund der niedergelassenen implantologisch tätigen Zahnärzte in Deutschland (BDIZ)« were studied with a scanning electron microscope (SEM).

We present three cases which demonstrate the opportunities of the failure analysis.

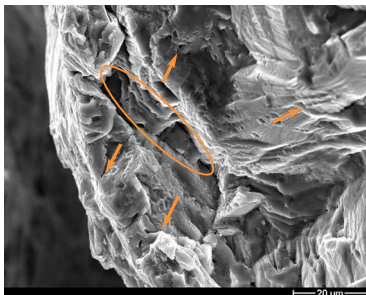
## Results

### Case 1: Hollow cylinder implant

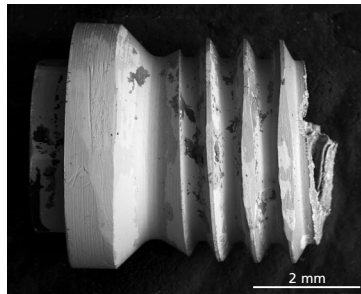


Starting point of the crack:

- Inclusion (material defect)
- Partial degeneration of the bone: higher loads in the region of the inclusion became critical

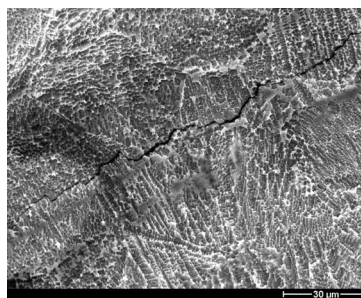


### Case 2: Screw implant



Etching of the surface:

- Increased roughness, supports bonding with bone structure
- Created local etching pits and grooves following the grain boundaries
- Locally accumulated stresses
- Acceleration of fatigue failure

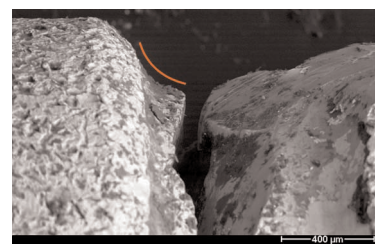
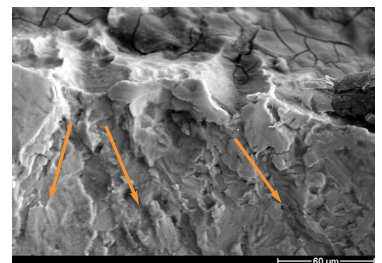


### Case 3: Screw implant



Sandblasting of the implant:

- Increased roughness, supports bonding with bone structure
- Created notches on the surface
- Notches and step in the diameter of the implant lead to locally accumulated stresses
- Acceleration of fatigue failure



## Conclusions

Failure analysis enables us to determine factors which contribute to the failure of implants. In particular for implants which underwent a roughening of the surface, it would be interesting to find the optimal surface roughness which on the one hand supports osseointegration and at the other hand results in a sufficient fatigue resistance.