

# Analysis of Imperfections in Dental Inlays using $\mu$ CT

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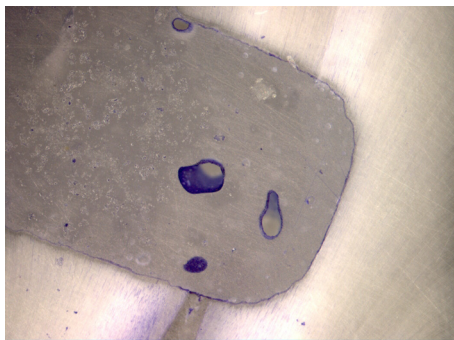
## INTRODUCTION



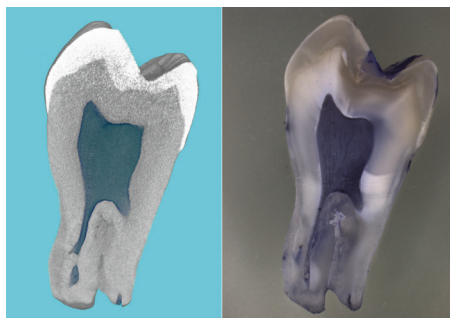
Adhesive tooth restoration with polymer composites is a widespread technique for replacing existing inadequate/fractured material or restoring of caries-affected teeth. The traditional method of analyzing the quality of the procedure is based on tooth coloring and cutting. The main disadvantage of this approach is that only imperfections in the cutting plane become visible. Micro-CT is a nondestructive way to create a volumetric 3D-data set of the inner structure of the inspected tooth with the possibility to generate any desired virtual cut through the filled tooth and to detect any micrometer-sized imperfection inside the restoration material.

## GAPS IN INLAYS

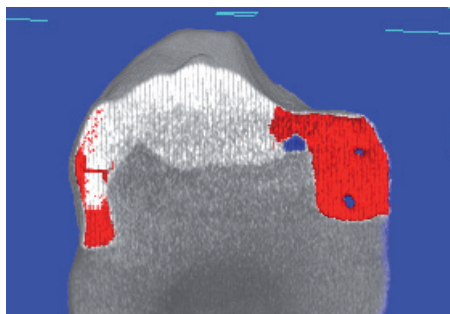
Defects between tooth and restoring material due to insufficient bonding or air inclusions in the material can be formed during the restoration process. Conventionally, these are made visible through staining of the tooth. The blue color collects near the boundaries of the structure, making holes easily spottable.



## 3D-DATA



A comparison between a computer generated image of a tooth with micro-CT vs. the photograph of a cut.



Micro-CT allows cutting the 3D dataset of the tooth in any desired direction, as shown above by axial and sagittal cuts. The inlay is marked in red while the pores are blue colored.

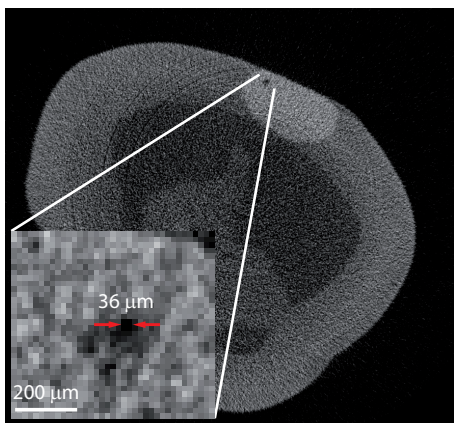
## MICRO-CT

In micro-CT several radiographic projections of a sample are taken at different angles. The sample is placed on a holder and put inside the scanner. During acquisition the sample rotates around its own axis in fine steps. Each step a radiograph is taken, which are then used to calculate a 3D dataset of the scanned sample. The number of rotation steps and images taken influences the quality of the reconstructed dataset, so a higher number of steps increases the dataset resolution, but also leads to a longer scan time. A short scan with reasonable settings takes about 30 min, while a scan with higher resolution may take several hours.



Skyscan 1174 (Skyscan Belgium) with 50 kV acceleration voltage and 800 mA beam current.

## RESOLUTION



To determine the resolution of a CT-image, a picture of a sharp edge is taken. The Fourier-transform of the profile of the edge the magnitude of the spatial frequencies contained in the image is obtained. Resolution is then defined as the frequency which magnitude corresponds to 10% of the maximal amplitude. For an image taken at 20.8  $\mu$ m pixel size objects as big as 1.3 pixels or 26.7  $\mu$ m can be spatially resolved.

## CONCLUSION

To evaluate the quality of a composite inlay an analysis of the inner structure of the tooth is necessary. The traditional analysis method, which consists in cutting the tooth, does not allow spotting the defects present in the inlay. Micro-CT allows non-destructively inspecting the inner structure of samples that can only partially be inspected by real cuts.

## ACKNOWLEDGEMENT

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