High-energy microtomography using synchrotron radiation at PETRA III / DESY for the 3D characterization of caries lesions

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INTRODUCTION: In the present study synchrotron radiation-based microtomography was applied to characterize a human tooth with rather small, natural caries lesions and an artificially induced lesion provoked by acidic etching. The high X-ray photon statistic allows to access the detailed spatial distribution of the mineral loss induced by caries.

MATERIALS & METHODS: We perform high density resolution micro tomography using monochromatized synchrotron radiation optimized for the investigation of the spatial distribution of the mineral loss in human tooth. Since the dose for such studies is intolerable the measurement was perfomed after tooth extraction. The selected human tooth shows several natural caries lesions. The tooth was cut into two parts. One half was treated by acidic etching to induce an artifically lesion. The experiment was performed at the beamline P07 operated by HZG at the storage ring PETRA III at DESY, Hamburg, Germany. Both halves of the tooth were separately visualized from 2400 radiographs with an asymmetric rotation axis using the photon energy of 45 keV.

RESULTS: In figure 1 the demineralization caused by natural caries can clearly be seen. The 3D representation of this part of the tooth is shown in figure 2 (top). The volume rendering of the second half of the tooth treated by acidic etching is shown in figure 2 (buttom).

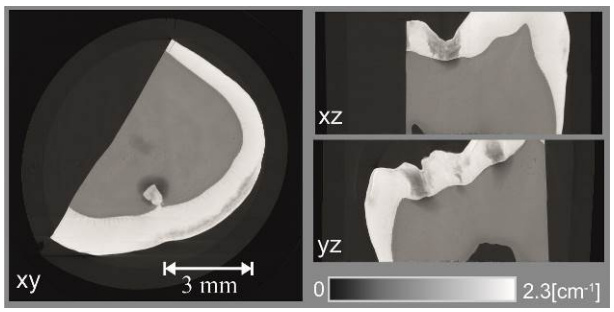

Fig. 1: Reconstructed slice (left) and vertical cuts through the reconstructed volume (right) of one half of a human tooth after extraction showing the demineralization due to natural caries

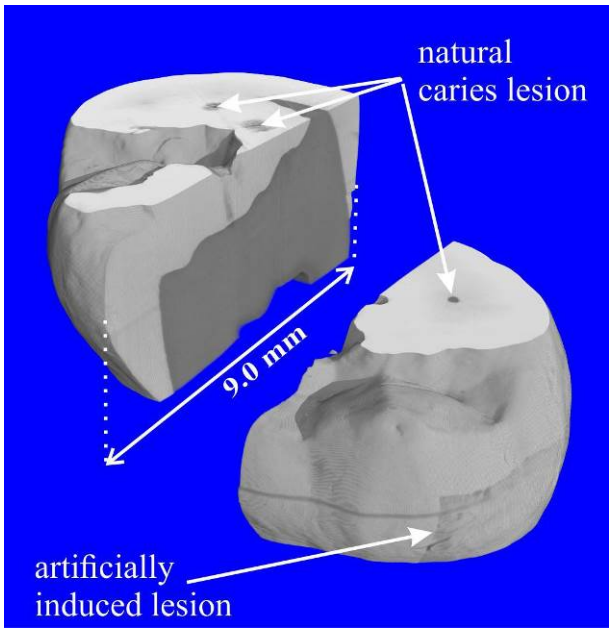

Fig. 2: Volume rendering of the two halves of the human tooth showing the location of the natural caries lesions and the artificially induced lesion..

DISCUSSION & CONCLUSIONS: The presented study allows us to compare natural and artificial lesion within the same tooth. This enables us to judge how far the man-made etching procedure corresponds to the naturally occurred caries process. Such a comparison is essential for reliable tests of remineralization strategies, as the artificial lesions can be prepared in reproducible manner for the optimization purposes.

REFERENCES: [1]H. Deyhle et al. (2014) *Nanostructure of the carious tooth enamel lesion* Acta Biomaterialia 10 (1) 355-364.

[2]F. Beckmann et al. (2008) *High density resolution microtomography* Proc SPIE **7078**: 70781D