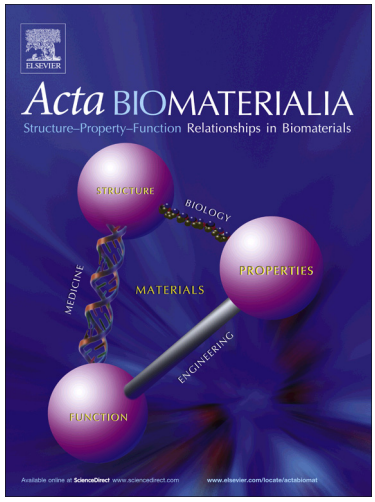

Full length article

In situ monitoring and analysis of enamel demineralisation using synchrotron X-ray scattering

Tan Sui, Enrico Salvati, Robert A. Harper, Hongjia Zhang, Richard M. Shelton, Gabriel Landini, Alexander M. Korsunsky

PII: S1742-7061(18)30421-5
DOI: https://doi.org/10.1016/j.actbio.2018.07.027
Reference: ACTBIO 5576

To appear in: *Acta Biomaterialia*

Received Date: 29 January 2018
Revised Date: 8 July 2018
Accepted Date: 14 July 2018

Please cite this article as: Sui, T., Salvati, E., Harper, R.A., Zhang, H., Shelton, R.M., Landini, G., Korsunsky, A.M., *In situ* monitoring and analysis of enamel demineralisation using synchrotron X-ray scattering, *Acta Biomaterialia* (2018), doi: https://doi.org/10.1016/j.actbio.2018.07.027

In situ monitoring and analysis of enamel demineralisation using synchrotron X-ray scattering

Tan Sui[1,3*], Enrico Salvati[1], Robert A. Harper[2], Hongjia Zhang[1], Richard M. Shelton[2], Gabriel Landini[2], Alexander M. Korsunsky[1*]

[1] Department of Engineering Science, University of Oxford, Parks Road, Oxford, OX1 3PJ, U.K.

[2] School of Dentistry, College of Medical and Dental Sciences, University of Birmingham, 5 Mill Pool Way, Edgbaston, Birmingham, B5 7EG, U.K.

[3] Department of Mechanical Engineering Sciences, University of Surrey, Guildford, Surrey, GU2 7XH, U.K.

* Corresponding authors: t.sui@surrey.ac.uk; alexander.korsunsky@eng.ox.ac.uk

Abstract

Dental caries is one of the most common chronic diseases that affect human teeth. It often initiates in enamel, undermining its mechanical function and structural integrity. Little is known about the enamel demineralisation process caused by dental caries in terms of the microstructural changes and crystallography of the inorganic mineral phase. To improve the understanding of the carious lesion formation process and to help identify efficient treatments, the evolution of the microstructure at the nano-scale in an artificially induced enamel erosion region was probed using advanced synchrotron small-angle and wide-angle X-ray scattering (SAXS and WAXS). This is the first *in vitro* and time-resolved investigation of enamel demineralisation using synchrotron X-ray techniques which allows *in situ* quantification of the microstructure evolution over time in a simulated carious lesion. The analysis revealed that alongside the reduction of mineral volume, a heterogeneous evolution of hydroxyapatite (HAp) crystallites (in terms of size, preferred orientation and degree of alignment) could be observed. It was also found that the rate and direction of dissolution depends on the crystallographic orientation. Based on these findings, a novel conceptual view of the process is put