Analysis of structural changes at interfaces of dental tissues by EDIXS and FTIR

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In this paper, we report a study of an important property of biomineralized phases, such as crystallinity, by using two different spectroscopic techniques. Crystallinity is not only important for understanding biomineralization, but it is also related to the maturation and growth mechanisms of calcium phosphates in biological surroundings [1-4].

Hard dental tissues like dentine and cementum were studied in several human dental pieces of adult individuals from the same geographic region. Crosscuts of several teeth were performed at dental root level resulting in a planar slice exposed for analysis. Two types of analyses were performed along linear paths crossing the dentine–cementum or root-dentine interfaces and all over a surface: Energy Dispersive Inelastic X-Ray Scattering (EDIXS) [5] and Fourier-Transform Infrared spectroscopy (FTIR) [6].

The EDIXS technique has the advantage of allowing to perform spatially-resolved structural analysis. The analysis was focused on the calcium absorption edge because this major element has a fundamental role in the formation of the calcium phosphate structure. Regarding FTIR, the investigation focused on the study of ν1–ν3 infrared absorption bands of PO4 3– phosphates.

The EDIXS measurements were carried out at the IAEA end-station [7] of the XRF beamline at the Elettra Sincrotrone Trieste, Italy. The FTIR measurements were performed in the Infrared Spectroscopy and Microspectroscopy beamline of the National Synchrotron Radiation Laboratory (UST, China).

With both techniques, the results confirm for the first time previous assumptions about the growth and maturation of dental calculi, i.e., crystallinity progresses from regions of high crystallinity to regions of lower crystallinity, and, in addition, its quantification with spatial resolution, observing a gradual pattern in dental calculus. Another outcome from this study was that cementum and dentine had similar crystallinity, despite their different biological and mechanical functions.

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