Characterization of Dental Demineralization Using a Biothermophotonic Technique

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Incipient dental demineralization is very difficult to detect or monitor with either x-rays or visual examination. High-resolution techniques, such as scanning electron microscopy are *ex-situ* and usually require destruction of the sample. In this study, Dental Photo-Thermal Radiomety (DPTR), one of the most prominent biothermophotonic approaches developed at the University of Toronto, is applied as a safe, non-destructive, and highly sensitive tool for the early detection of incipient dental caries.

In the DPTR experiments, sequential etching with 37% phosphoric acid gel was applied to simulate controlled mineral loss on the enamel surface. Modulated laser light in the visible range generated infrared blackbody radiation from teeth. The infrared flux emitted by the etched region of the tooth surface was monitored with an MCT infrared detector twice: before and after etching. The results showed the capability of DPTR to detect early mineral loss even after 5 s of a shallow etching treatment, while radiographs didn't indicate any changes even after a 1-min treatment. A coupled diffuse-photon-density-wave and thermal-wave theoretical model was developed to describe the biothermophotonic phenomena in a two-layer turbid medium. The model resulted in measurements of optical as well as thermal properties of the etched enamel. As a result, the DPTR technique was shown to be a powerful diagnostic tool for the detection of early demineralization of tooth enamel.