Biothermophotonic Studies of Deep Carious Lesions in Teeth using Simultaneous Infrared Photothermal Radiometry and Modulated Laser Luminescence Diagnostics

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Simultaneous measurements of the frequency-domain photothermal radiometric (PTR) and the modulated laser luminescence (LUM) signals from human teeth have been performed toward detecting deep lesions or subsurface defects. At a fixed frequency, two semiconductor laser diodes with wavelengths in the tissue optical window near-IR range were used as modulated light sources to scan along the tooth surface and a HgCdTe infrared detector and a photodiode detector were used for measuring the PTR and LUM signals (amplitude and phase) respectively. Several teeth were examined, and the combined technique was found to hold promise for depth profilometric biothermophotonic diagnosis of sub-surface caries. PTR amplitude from carious regions in teeth and from thin enamel were higher than those from healthy teeth and thicker enamel. A crack produces a peak in the PTR amplitude scan, as well as a sudden change in the LUM amplitude at the corresponding point. With respect to frequency dependence, at a low frequency (5 Hz) the PTR amplitude showed sensitivity to very deep lesions (including man-made holes), indicating IR photon radiation heat transfer from deep regions inside the tooth. At high frequency (700 Hz) the PTR signal was more sensitive to surface cracks. The talk will present several case studies of healthy and deeply carious teeth, as well as teeth afflicted with intermediate degress of demineralization. It will be shown that by selecting proper modulation frequencies of the laser and proper excitation wavelength, biothermophotonic measurements of PTR and LUM signals could be used as an effective dental diagnostic technique.