DENTAL DIAGNOSTIC CLINICAL INSTRUMENT ("CANARY") DEVELOPMENT USING PHOTOTHERMAL RADIOMETRY AND MODULATED LUMINESCENCE

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Since 1999, our group at the CADIFT, University of Toronto, has developed the application of Frequency Domain Photothermal Radiometry (PTR) and Luminescence (LUM) to dental caries detection. As a result, some of the inherent advantages of the adaptation of this technique to dental diagnostics in conjunction with modulated luminescence as a dual-probe technique have been reported [1-4]. Based on these studies, a portable, compact diagnostic instrument for dental clinic use has been designed, assembled and tested. As shown below, a semiconductor laser (660nm, 120mW) with a driver, a thermoelectric cooled mid-IR detector, a photodiode for luminescence detection, a data acquisition board and a computer were packaged inside a box including 3 types of optical fibers to deliver laser light to a tooth and to collect thermal infrared and luminescence. At the end of the fiber bundle, a hand piece with electric switches to control laser and data acquisition is attached. An intra-oral camera was also connected through a USB port to capture tooth image and to record measurement positions.

A data acquisition card (National Instruments) with built-in signal generation features was used to generate sinusoidal signals and to record responses from the IR and photo detectors. Software lock-in amplifier techniques were developed to compute amplitude and phase of PTR and LUM signals. In this system, sampling time for measurements at each enamel point was reduced to a few seconds using swept sine waveforms. A sophisticated software interface was designed to simultaneously record intra-oral camera images with photothermal and luminescence responses. Computed results after normalization and corresponding tooth images are displayed in real time.

Currently, further efforts are expended to improve signal reception at the hand piece and to increase data acquisition speed. Preliminary results from the use of this instrument during clinical trials in a dental clinic setting will be reported.

[1] L. Nicolaides, A. Mandelis, and S. H. Abrams, J. Biomed. Opt. **5**, 31 (2000)
[2] R. J. Jeon, C. Han, A. Mandelis, V. Sanchez, and S. H. Abrams, Caries Res. **38**, 497 (2004)
[3] R. J. Jeon, A. Mandelis, V. Sanchez, and S. H. Abrams, J. Biomed Opt. **9**, 804 (2004)
[4] R. J. Jeon, A. Matvienko, A. Mandelis, S. H. Abrams, B. T. Amaechi, and G Kulkarni, J. Biomed Opt. **12**, (2007).

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