

Detecting caries at the margins of restorations with The Canary System

By Stephen Abrams, DDS

Caries detection around the margins of restorations is a major challenge in clinical practice. Typically, the restorative material will impede the detection system from accurately examining the margins for caries. However, The Canary System, powered by an energy conversion technology (PTR-LUM), provides the solution. The Canary System™ directly examines the status of the tooth crystal structure. Rapid, safe pulses of laser light combining infrared and luminescence allow users to examine lesions as small as 50 microns and subsurface caries up to 5 mm below the tooth surface or along the margin of composites and amalgams.

Detection of caries around the margins of a Class V amalgam restoration can be a challenge. Figures 2 and 3 illustrate a patient who was at very low risk for developing caries. The existing restoration was placed more than 30 years ago; the margins were intact; oral hygiene was excellent; and no restorations had been placed or replaced in the last 15 years. Radiographs could not image the restoration margins and the amalgam restoration on the buccal or occlusal part of the tooth may have created a silver stain or halo around the margin. The Canary Number of 76 from scanning around the margin indicated advanced caries around the restoration. Upon removal of the amalgam, a large carious lesion was found extending well beyond the margins of the restoration. Therefore, the subsurface caries that would have otherwise gone undetected, possibly requiring a root canal, successfully detected by The Canary System by examining for decay around the margins of this restoration.

Research shows that PTR-LUM technology used in The Canary System can detect:

- Occlusal pit and fissure caries³
- Smooth surface caries^{4,5}
- Acid erosion lesions^{6,7}
- Root caries^{8,9}
- Interproximal caries lesions^{10,11}
- Demineralization and remineralization of early caries lesions¹²⁻¹⁵

The Canary System captures both signals and images of the tooth surfaces being examined. These images are displayed on an accompanying interactive, touch-screen monitor for immediate chairside review with the patient who can also take home a printed Canary Report. The Canary System creates an opportunity for dialogue and co-diagnosis, two strong motivators for a new long-term, recurring patient relationship. Odontograms also are added to patients' files so treatment progress can be monitored over time. The data is saved on the Canary computer, and merged into detailed user-friendly reports.

These unique characteristics of The Canary System provide a clinical practice with the ability to monitor the entire spectrum of the caries process; from initial demineralization to caries beneath pits and fissures and around restoration margins. The Canary System will enable a practice to provide preventive minimally invasive oral health care.

NOTE: Dr. Stephen Abrams is the CEO and co-founder of Quantum Dental Technologies, which has developed The Canary System mentioned in this article. He has not received any compensation for the preparation of this article.

STEPHEN ABRAMS, DDS, is a general dental practitioner with more than 30 years of clinical experience. Upon graduation from the University of Toronto Faculty of Dentistry in 1980 he established a group practice in Toronto, which has grown to involve general dentists and dental specialists. In 1999, Dr. Abrams began working on a non-invasive laser based device for the detection and monitoring of caries. He jointly holds patents on this new technology. In 2006, he founded Quantum Dental Technologies to finish development of The Canary System. The Canary System, which is based upon the PTR-LUM technology, is currently available in Canada and Europe.

He is a senior member of the European Organization for Caries Research (ORCA) where he has presented a number of papers on the detection of caries using The Canary System. Abrams has published more than 90 articles in various international publications on topics ranging from early caries detection, prevention, removable dentures, design of dental programs and restorative dentistry.

Abrams has honorary fellowships in a number of dental societies, including Pierre Fauchard and the International College of Dentists. He is a member of Alpha Omega Dental Fraternity. He has been very active in the Ontario Dental Association, chairing its Dental Benefits Task Force for the last 13 years, negotiating with the provincial government and local municipalities across Ontario on various government-sponsored dental programs. He has dealt with issues of access to dental care, design of dental programs and the value of preventive dentistry, while leading this ODA task force. In 2002, Abrams was awarded the Barnabus Day Award from the Ontario Dental Association for 20 years of distinguished service to the dental profession. He is one of the founding board members of ACCERTA Claim Corporation, a dental and pharmacy claims management company.

References

1. Jeon, R. J., Han, C., Mandelis, A., Sanchez, V., Abrams, S. H., "Dental Depth Profilometric Diagnosis of Pit & Fissure Caries using Frequency-Domain Infrared Photothermal Radiometry and Modulated Laser Luminescence", *Early Detection of Caries III Proceedings of the Sixth Indiana Conference Indiana University School of Dentistry*, pages 49-67, Stookey, G., editor, 2003
2. Jeon, R. J., Han, C., Mandelis, A., Sanchez, V., Abrams, S. H., "Diagnosis of Pit & Fissure Caries using Frequency-Domain Infrared Photothermal Radiometry and Modulated Laser Luminescence" *Caries Research* 2004; 38: 497-513.
3. R. Jeon, A. Mandelis and S. Abrams, "Dental depth profilometric diagnosis of pit and fissure caries using frequency-domain infrared photothermal radiometry and modulated luminescence", *SPIE Vol. 5320, Photons plus Ultrasound: Imaging and Sensing* (A. A. Oraevsky and L. V. Wang, Eds., Bellingham WA 2004, pp. 29, 39.
4. Jeon, R. J., Han, C., Mandelis, A., Sanchez, V., Abrams, S. H., "Non-intrusive, Non-contacting Frequency-Domain Photothermal Radiometry and Luminescence Depth Profilometry of Carious and Artificial Sub-surface Lesions in Human Teeth," *Journal of Biomedical Optics* 2004, July-August, 9, # 4, 809-819.
5. Jeon, R. J., Mandelis, A., Abrams, S. H., "Depth profilometric case studies in caries diagnostics of human teeth using modulated laser radiometry and luminescence," *Review of Scientific Instruments*, 2003; 74 (1): 380-383.
6. Jeon R. J., Phan T. D. T., Wu A., Kulkarni G., Abrams S. H., and Mandelis A., "Photo-thermal radiometric quantitative detection of the different degrees of demineralization of dental enamel by acid etching," *J. Physique IV France*, 2005; 125: 721-72.
7. Abrams, SH., Matvienko, A., Ye, V., Man-



Fig. 1: The Canary System displaying scanning results. Photos/ Provided by The Canary System

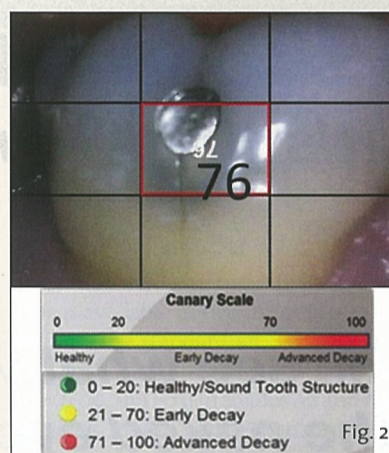


Fig. 2



Fig. 3

Fig. 2: Canary Scan results.

Fig. 3: Mandibular molar with small buccal amalgam restoration and no visible marginal defects.

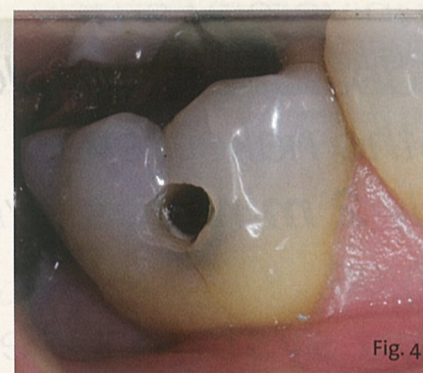


Fig. 4

Fig. 4: Amalgam restoration removed showing caries around the margins, especially along the gingival floor.

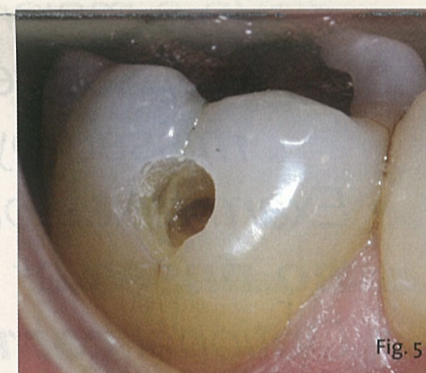


Fig. 5

Fig. 5: Preparation complete showing the extent of the caries.

- delis, A., Ramalingam K., Amaechi, BT. "Detection and monitoring of dental erosion using PTR-LUM". *International Association of Dental Research (IADR)*, Abstract #238 [San Diego, CA, USA] March 2011.
8. Jeon, R. J., Hellen, A., Matvienko, A., Mandelis, A., Abrams, S. H., Amaechi, B. T., "Detection of Demineralized-Remineralized Lesions on Root and Enamel of Human Teeth in vitro using Infrared Photothermal Radiometry and Modulated Luminescence", *ORCA Abstract #157, Caries Research* 2007, 41:323.
9. Jeon R. J., Hellen A., Matvienko A., Mandelis A., Abrams S. H., Amaechi B. T., "In vitro Detection and Quantification of Enamel and Root Caries Using Infrared Photothermal Radiometry and Modulated Luminescence." *Journal of Biomedical Optics*, 2008; 13(3), 048803.
10. Jeon R.J., Matvienko A., Mandelis A., Abrams S.H., Amaechi B.T., Kulkarni G. "Detection of interproximal demineralized lesions on human teeth in vitro using frequency-domain infrared photothermal radiometry and modulated luminescence," *J. BioMed. Optics*, 2007; 12(3); 034028 1-13.
11. Jeon, R. J., Matvienko, A., Mandelis, A., Abrams, S. H., Amaechi, B. T., Kulkarni, G., "Interproximal Dental Caries Detection using Photothermal Radiometry (PTR) and Modulated Luminescence (LUM)," *European Physical Journal, Special Topics*, 2008, 153; 467-469.
12. Jeon, R. J., Hellen, A., Matvienko, A., Mandelis, A., Abrams, S. H., Amaechi, B. T., "Detection of Demineralized-Remineralized Lesions on Root and Enamel of Human Teeth in vitro using Infrared Photothermal Radiometry and Modulated Luminescence", *ORCA Abstract #157, Caries Research* 2007, 41:323.
13. Matvienko, A., Mandelis, A., Hellen, A., Jeon, R. J., Abrams S. H., Amaechi, B., "Quantitative Analysis of Incipient Mineral Loss in Hard Tissues," (*SPIE BIOS*, San Jose, USA, January 2009), *Proc. SPIE BIOS Vol. 7166 (12)*, 71660C1-12 (April 2009).
14. Hellen, A., Mandelis, A. and Y. Finer, "Photo-thermal Radiometry and Modulated Luminescence Examination of Demineralized and Remineralized Lesions," *J Phys: Conf Ser* 2010; 214(1): 012024 [15th International Conference on Photoacoustic and Photothermal Phenomena, Leuven, Belgium, July 2009].
15. Matvienko, A., Amaechi, BT., Ramalingam, K., Macaden, M., Ye, V., Hellen, A., Jeon, R.J., Sivagurunathan, K., Mandelis, A., Abrams, SH., "PTR-LUM-based detection of demineralization and remineralization of human teeth." *International Association of Dental Research (IADR)*, Abstract #114 [San Diego, CA, USA] March 2011.