The Canary System
by Quantum Dental Technologies

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Detection of caries around restorations with The Canary System™

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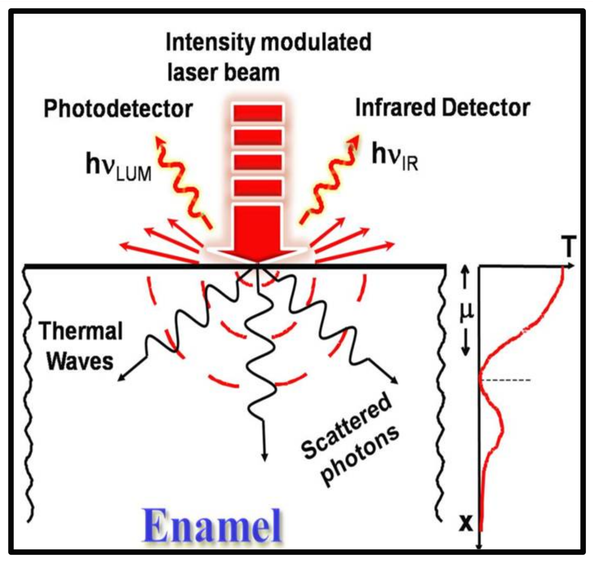
The Canary System™ Technology

Pulses of laser light are shone on the tooth and the laser light is converted to heat (Photothermal Radiometry or PTR) and light (luminescence or LUM) which are emitted from the tooth surface when the laser is off.

The Canary System™ measures four signals:
- ❑The strength of the converted heat (**PTR Amplitude**)
- ❑The time delay of the converted heat to reach the surface (**PTR Phase**)
- ❑The strength of the converted luminescent light (**LUM Amplitude**)
- ❑The time delay of the converted luminescent light (**LUM phase**)

The Canary Number is created from an algorithm combining these four signals and is directly linked to the status of the enamel or root surface crystal structure. Changes in the tooth microstructure, due to caries, causes corresponding changes in the optical and thermal properties of the tooth and the resultant PTR-LUM response .



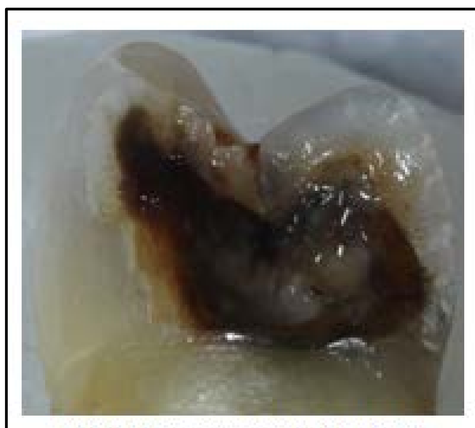
Objectives

A pilot *in vitro* study was conducted to:
1. Evaluate the ability of The Canary System™ to detect natural decay around composite restorations
2. Compare the efficacy of The Canary System™ to a laser fluorescence system (DIAGNOdent Classic™)

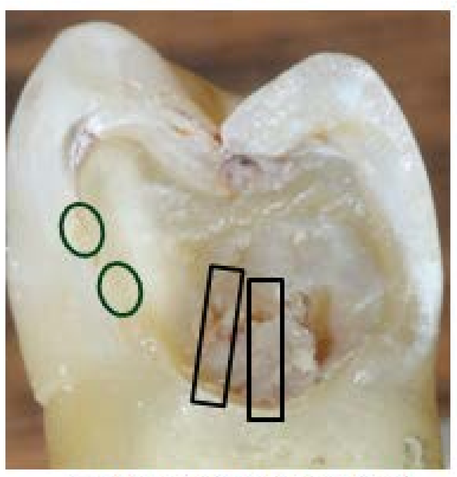
Materials & Methods

- ❑ Extracted human molars and premolars (n = 5) with a natural cavitated caries lesions were used.
- ❑ Bulk carious tissue was removed, leaving some decayed tissue on the axial and gingival walls of the cavity preparation.
- ❑ Cavity preparations were extended to sound enamel and dentin; mesio-distally onto sound enamel and gingivally onto sound root dentin, for bonding of the composite resin.
- ❑ Teeth were restored with Alert® Condensable Composite Resin, according to manufacturers instructions.
- ❑ Following restoration, 74 test sites at the margins of the restoration (MON), 0.5mm and 1mm away from the margins were scanned with The Canary System™ and DIAGNOdent™.
- ❑ Each examination site was scanned 5 times with The Canary System ™ and the average Canary Number (CN) reading was recorded; DIAGNOdent measurements were repeated 3 times and average peak value recorded.

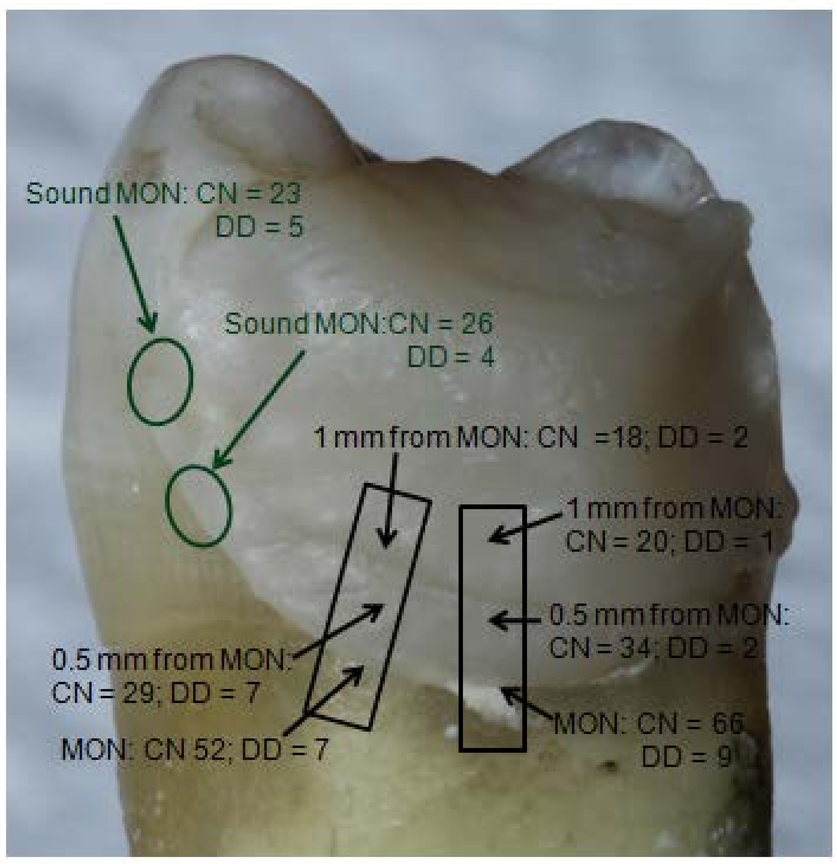
Results



(A) Before removal of natural carious tissue



(B) After removal of natural carious tissue

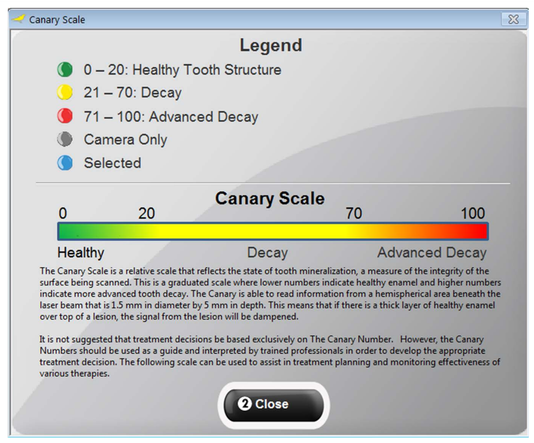


(C) After restoration with Alert® Condensable Composite with etching and bonding

Figure 1. A representative tooth sample with natural decay before (A) and after (B) removal of bulk decay. (C) Restored lesion with Alert® Condensable Composite. Sound margins of restoration (MON) (green circles) were scanned with The Canary System™ and DIAGNOdent™. Corresponding mean Canary Number (CN) and DIAGNOdent™ (DD) readings of the sound MON's are shown in green. Decayed areas (black rectangles) of the same sample were scanned with The Canary System™ and DIAGNOdent™ at distances from the restoration margin (0.5 mm and 1 mm onto the restoration). Corresponding mean CN and DD readings of the carious areas are shown in black.

DIAGNOdent Scale (according to KaVo)	
Display value:	**Therapy:**
0 - 14	No special measures.
15 - 20	Prophylactic measures.
21 - 30	Intensive prophylaxis/restoration: Indication dependent on * caries activity. * caries risk. * recall interval, etc.
from 30	Restoration/intensive prophylaxis.

(A) DIAGNOdent Scale



(B) The Canary Scale

Figure 2. (A)DIAGNOdent Scale according to KaVo; (B) The Canary Scale is a relative scale of 0 - 100 that reflects the state of tooth mineralization and crystallization. This is a graduated scale where lower numbers indicate sound enamel and higher numbers indicate more advanced tooth decay.

Table 1. Mean ± SD of The Canary System™ and DIAGNOdent™ recordings at sound and carious restoration margins.

	The Canary System™	**DIAGNOdent™**
Sound Margin	26 ± 5	11 ± 7
Carious Margin	56 ± 11*	15 ±12

* $p < 0.05$ for difference between sound compared with carious MON (independent-samples Mann-Whitney U Test).

Table 2. Mean ± SD of The Canary System™ and DIAGNOdent™ recordings at different distances from the restoration margins.

Distance from restoration margin	**The Canary System™**	**DIAGNOdent™**
0 mm (directly at margin)	56 ± 11	15 ± 12
0.5 mm onto restoration	32 ± 5	8 ± 9
1 mm onto restoration	19 ± 3	4 ± 4

Discussions

- ❑ Canary Numbers (CN) were significantly higher on areas of the restoration with significant underlying decay compared to sound restoration margins.
- ❑ High CN at distances from the restoration margin (0.5 mm into the restoration) demonstrate the ability of The Canary System™ to detect decay at a distance from the scanned area, a function of the diffuse optical and thermal fields arising within the tooth upon excitation with the incident light.
- ❑ Thermal wave (heat) diffusion to surrounding areas can detect decay even at a distance from the initial point-scan location; a unique feature of photothermal (PTR) techniques
- ❑ DIAGNOdent™ readings at sound and carious margins were not significantly different in this study, suggesting that secondary caries may potentially be underestimated.

Conclusions

- ❑ This pilot study suggests that The Canary System™ has the potential to detect secondary caries around composite restorations more accurately than DIAGNOdent™.
- ❑ Further studies of greater statistical power are currently in progress.
- ❑ The Canary System™ may be a valuable adjunct to conventional methods for detecting secondary caries on teeth with composite restorations.