Bioactive Dental Materials

Cavity Liners, Bases, and Dentin Replacements

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Cavity liners have historically been used to protect the pulp from the toxic effects of some dental restorative materials and to prevent the pain of thermal conductivity by placing an insulating layer between restorative material and the remaining tooth structure.

Bases can be considered as restorative substitutes for the dentin that was removed by caries and/or the cavity preparation. They act as a barrier against chemical irritation, provide thermal insulation, and can resist the condensation forces on a tooth when placing a restoration.

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Calcium Hydroxide – "Gold Standard" for Pulp Capping ??
Soluble and Contraindicated Under Bonded Restorative Materials

Bioactive Cavity Liners with Calcium and Phosphate Availability – Indicated for Indirect Pulp Cap Only

3

Cytotoxicity of resin-based light-cured liners.
Hebling J, Lessa FC, Nogueira I, Carvalho RM, Costa CA. *Am J Dent.* 2009 Jun;22(3):137-42.

American Journal of Dentistry, Vol. 22, No. 3, June, 2009

Research Article

Cytotoxicity of resin-based lig

JOSIMERI HEBLING, DDS, MS, PhD, FERNANDA C … S, MS, INDRI NOGUEIRA, DDS, MS,
RICARDO MARINS DE CARVALHO, DDS, MS, PhD SOUZA COSTA, DDS, MS, PhD

ABSTRACT: Purpose: To evaluate the … ased light-cured liners on culture of pulp cells. **Methods:** Discs measuring 4 mm in di … : fabricated from TheraCal (TCMTA), Vitrebond (VIT), and Ultrablend Plus (UBP). These specimens were immersed in serum-free culture medium (DMEM) for 24 …

In conclusion, all the resin-based liners tested were toxic to the cultured odontoblast-like cells. However, among the materials, the light-cured resin-based MTA cement presented the lowest cytopathic effects.

TCMTA group resembled those from the control group while for VIT and UBP the cells presented significant morphological alterations. (*Am J Dent* 2009;22:137-142).

CLINICAL SIGNIFICANCE: Several resin-based dental cements have been recommended to be applied as liners or pulp-capping agents. In the present *in vitro* investigation, it was demonstrated that a new light-cured MTA cement presented low cytopathic effects to cultured pulp cells.

✉: Dr. Carlos Alberto de Souza Costa, University of São Paulo State, UNESP, Rua Humaitá, 1680 - CEP: 14.801-903, Araraquara, SP, Brazil. E-✉: casouzac@foar.unesp.br

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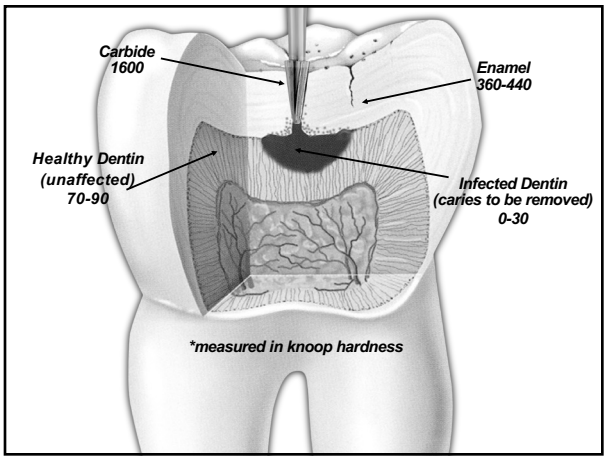

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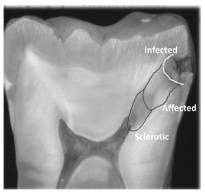
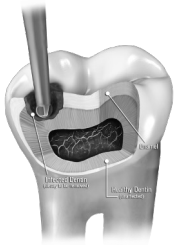
Decay Removal





Studies Show SmartBur II Cuts Decay, But Not Healthy Dentin, Therefore Avoiding Inadvertent Pulp Exposure and leaving Affected Dentin for Potential Remineralization from Bioactive Dental Materials

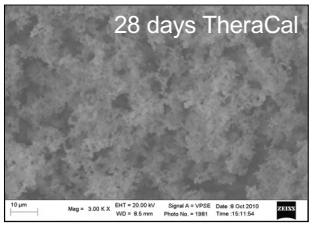
6

TheraCal LC – Bioactive liner

TheraCal LC is a light-cured resin-modified calcium silicate pulp protectant/liner designed to perform as a barrier and to protect the dental pulpal complex.

7

J Dent Res 90 (Spec Iss A):abstract number 2520, 2011 (www.dentalresearch.org).
Apatite-forming Ability of TheraCal Pulp-Capping Material
M.G. GANDOLFI1, F. SIBONI1, P. TADDEI2, E. MODENA2, and C. PRATI1



Conclusion: TheraCal was able to induce the formation of apatite and represents a promising material in direct pulp-capping clinical procedures. The ability to form apatite may play a critical/positive role in new dentine formation.

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TheraCal LC - Indications for Use

DIRECT PULP CAPPING
- *Carious Exposures*
- *Mechanical Exposures*
- *Exposures due to trama*

INDIRECT PULP CAPPING
- *Under Amalgam restorations*
- *Under Class I & II composite Restorations*
- *Under other base materials*
- *Under cements*
- *As an alternative to:*
  - *Calcium Hydroxide*
  - *Glass Ionomer/RMGI*
  - *Cavity Varnish Sealer*

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TheraCal LC

Unique Benefits and Clinical Significance

Calcium Release affects:
1. *Mechanical Sealing of the pulp*
2. *Hydroxy apatite formation*
3. *Secondary bridge formation*

Alkaline pH promotes Healing and Apatite formation

Moisture tolerant - improves the ability to form a durable seal

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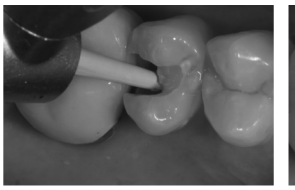
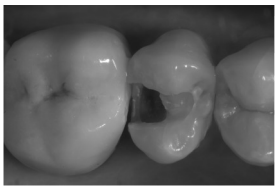
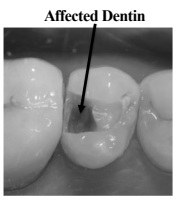
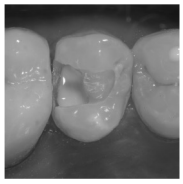






GJ Mount, A New Paradigm For Operative Dentistry, Australian Dental Journal, Vol. 52, #4, December, 2007, pp. 264-270.



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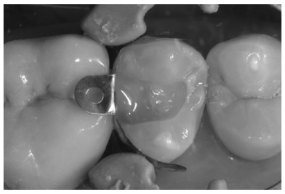

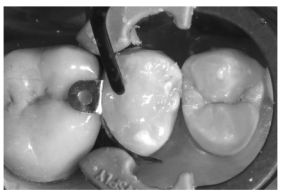

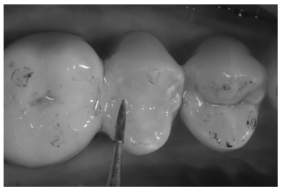

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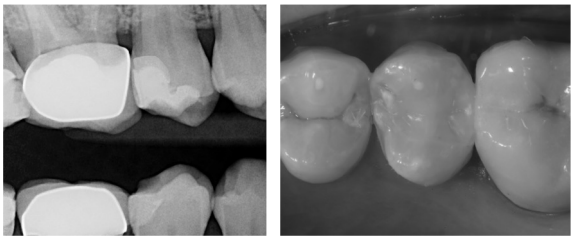

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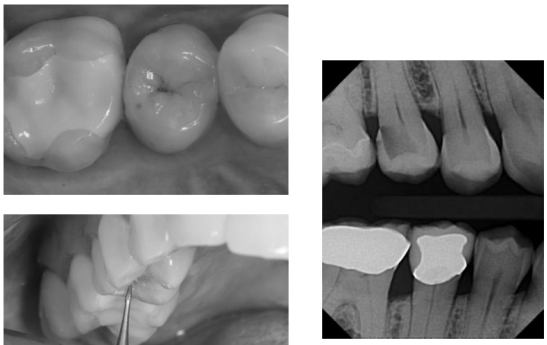

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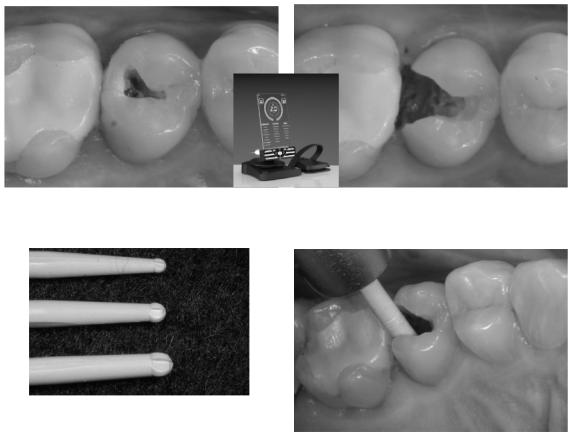

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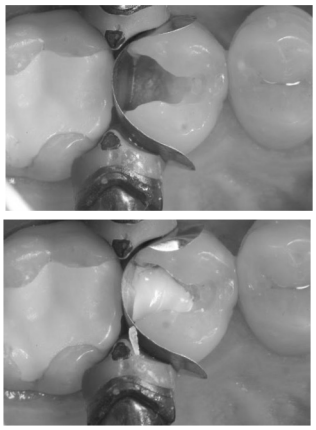

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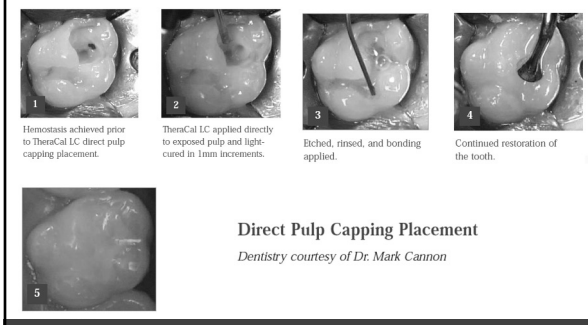
Direct Pulp Capping



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TheraCal PT®

TheraCal PT is a biocompatible, dual-cured, resin-modified calcium silicate designed for pulpotomy treatment.

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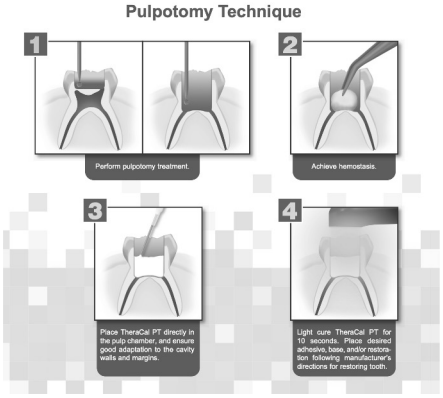

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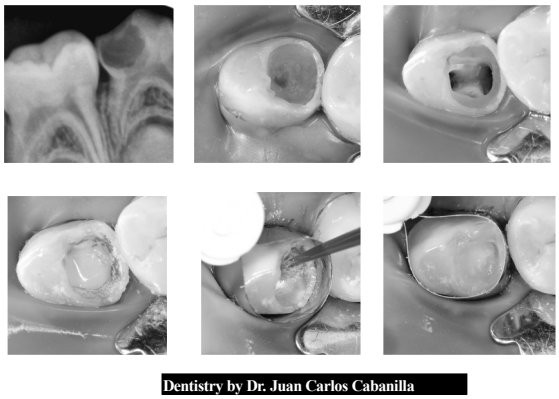

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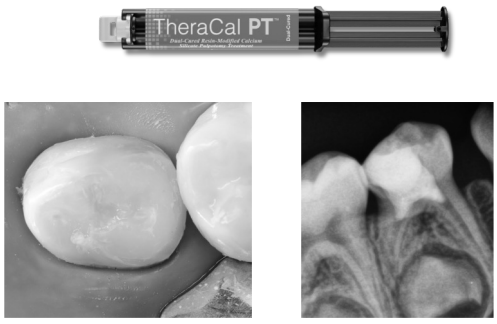

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Bioactive Dental Materials

Glass Ionomer Cements As Dentin Replacements

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Benefits Of Using Glass Ionomer Cement As A Dentin Replacement In Deeply Excavated Lesions

- *More tubules exposed, less peritubular dentin to bond to. Glass Ionomer Cement forms a "chemically fused seal" (Ngo)*
- *High Fluoride Release For Internal Remineralization*
- *Negligible Shrinkage – Same CTE as Dentin*

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New Delivery - Fuji Automix LC

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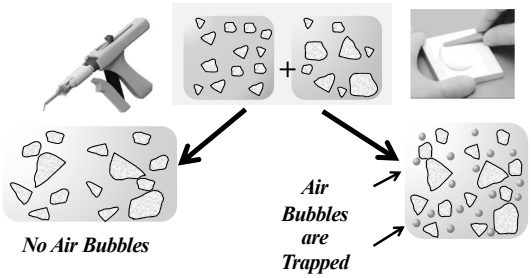
Advantage of Fuji Automix LC



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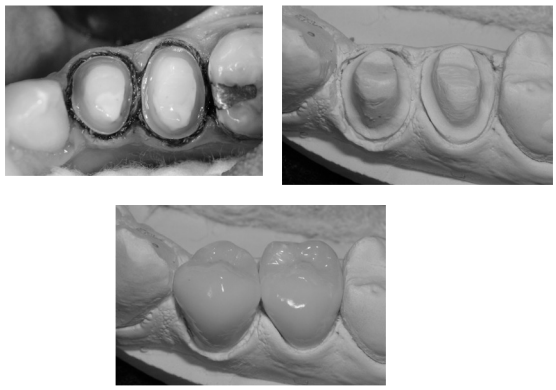

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Direct Composite Resin Utilizing Glass Ionomer As A Dentin Replacement

The "Open Sandwich" Technique

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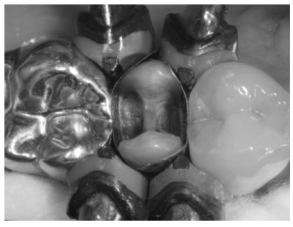
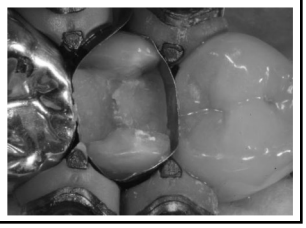


Root Caries Present on Mesial Aspect

Glass Ionomer Cement Placed After Placement of Tooth Conditioner and Through Rinse - "Open Sandwich Technique"



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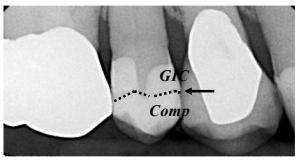
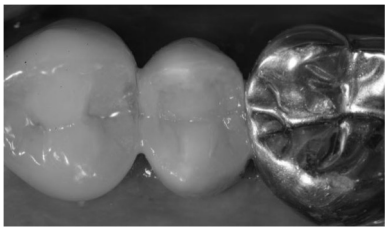


"Open Sandwich" GIC and Composite Resin



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TheraBase™

TheraBase is a dual-cure, calcium and fluoride releasing, self-adhesive base/liner

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TheraBase

Unique Benefits:

- **Continuous release of calcium and fluoride ions[1]**
- **Self-adhesive, no bonding agents required**
- **High compressive strength, absorbs shock and stress from occlusal forces without fracturing**
- **Radiopaque, allows for identification on radiographs and effective diagnosis**
- **Auto-mix, dual syringe provides a consistent mix for immediate delivery with zero to minimal waste of material**
- **Dual-cured material that will cure even in deep restorations where light cannot reach**

Clinical Benefits:

- **Generates an alkaline pH (pH=11*) in minutes, which promotes pulp vitality[2]**
- **Contains the adhesion promoting monomer MDP, ensuring reliable and optimal bond to dentin[3]**

*Data on file.
[1] Gleave CM, Chen L, Suh BI. Calcium & fluoride recharge of resin cements. Dent Mater. 2016 (32S):e26
[2] T. Okabe, M. Sakamoto, H. Takeuchi, K. Matsushima. Effects of pH on Mineralization Ability of Human Dental Pulp Cells. Journal of Endodontics. Volume 32, Number 3, March 2006.
[3] Hydrolytic stability of self-etch adhesives bonded to dentin, S Inoue 1, K Koshiro, Y Yoshida, J De Munck, K Nagakane, K Suzuki, H Sano, B Van Meerbeek, Journal of Dental Dentistry, December 2005

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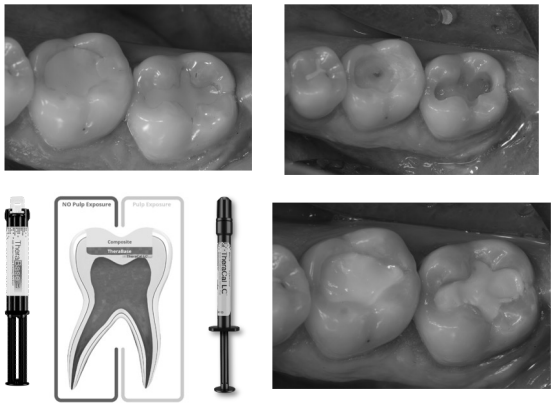

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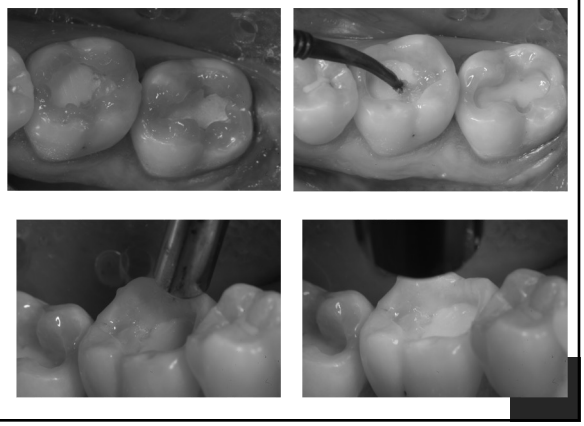

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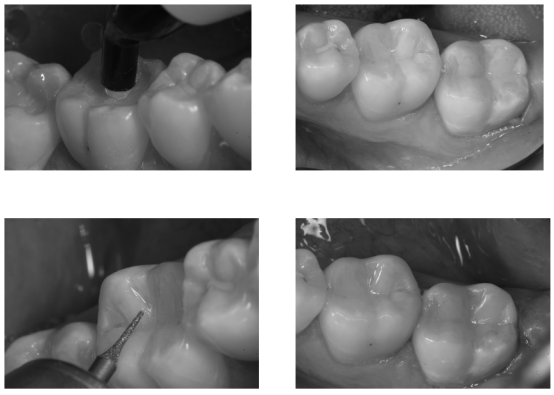

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BioDentine

TriCalcuim Silicate

Bioactive Dentin Substitute

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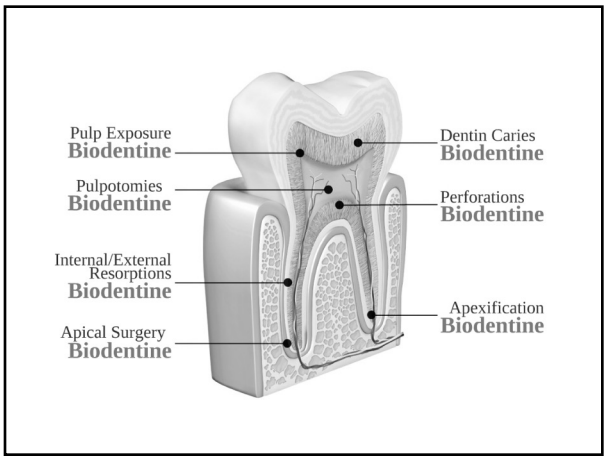

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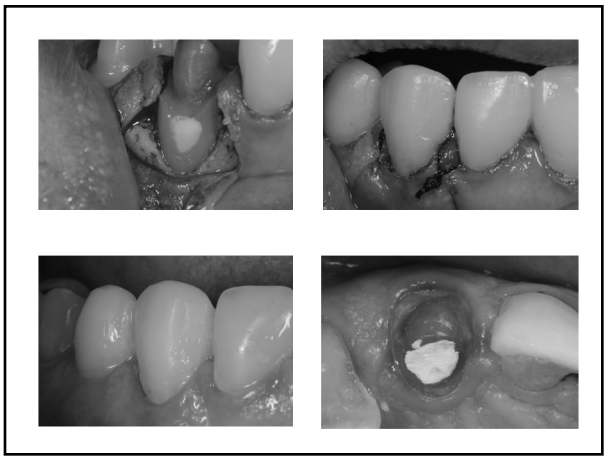

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Bioactive Dental Materials

Dental Cements

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Bioactive Dental Cements

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Bioactive Dental Materials

Resin Modified Glass Ionomer Cements (RMGI)

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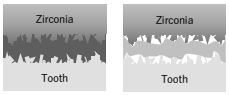
Fuji Cem EVOLVE

Excellent Bond Strength to Zirconium

- ✓ Excellent wettability thanks to hydrophilicity of super-long monomer chain of FujiCEM Evolve
- ✓ Chemical interaction between polyacrylic acid and zirconia



FujiCEM Evolve can wet zirconia surface without any primer. This enables higher luting strength.

In case of resin cements without primer, its insufficient wettability decreases bond strength.

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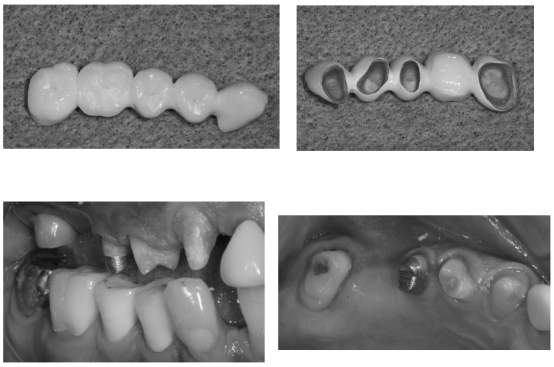

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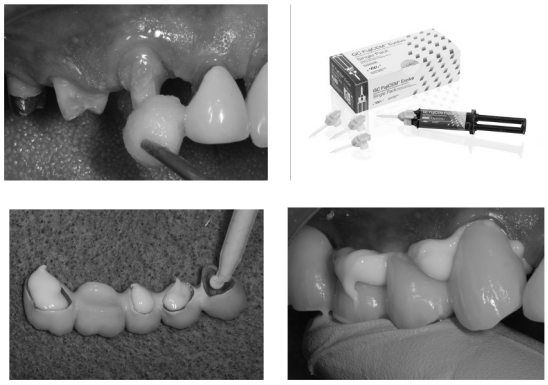

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Bioactive Dental Cements

Cementation On Natural Tooth Preparations Using Ceramir Crown and Bridge

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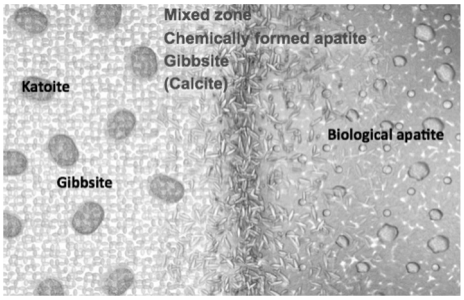
Ceramir Crown and Bridge = Chemically Bonded Bioceramic



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Comparison of Ceramir C&B to other Dental Material Classes (data on file)

	Ceramir C&B	Self-Adhesive Resin	Resin-Modified GI	Glass Ionomer
Sets at high pH, forms apatite	■			
No post-op sensitivity	■			
Exceptional retentive strength	■	■		
Superior biocompatibility	■			
No etching, priming, bonding or conditioning	■	■	■	
Easy clean-up	■		■	
Shown in preliminary study to close artificial marginal gaps[1]	■			

1 Jefferies SR, Fuller AD, Boston DW. Preliminary evidence that bioactive cements occlude artificial marginal gaps. J Esthet Restor Dent. 2015. doi:10.1111/jerd.12133. [Epub ahead of print]

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How is it different from other cements?
Ceramir C&B Comparison to other cement classes

ceramir CROWN & BRIDGE

Material Class	Ceramir Crown & Bridge	GI/RMGI	RESINS	SELF ADHESIVE RESIN	ZINC PHOSPHATE
Hydroxy Apatite Formation/ Self-seal	YES	NO	NO	NO	NO
Biocompatibility	EXCELLENT	fair/OK	OK	OK	good
pH	BASIC	acidic	acidic/neutral	acidic/neutral	acidic
Post-op Sensitivity	NO	YES	YES	YES	YES
Stability Over Time	STABLE	degrades	degrades	degrades	degrades

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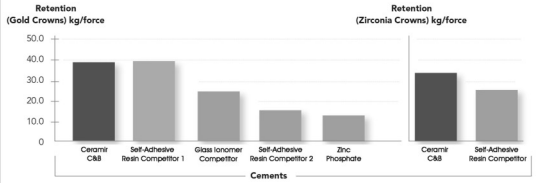
Exceptional Strength and Durability
▶PROVEN! Resin-cement-like retentive strength that protects the tooth over time[2]

Ceramir Crown & Bridge's retention is equal or superior to self-adhesive resin cements.



2 C.H. Pameijer, et al.: A comparative crown retention test using XeraCem™, J. Dent Res. 2008; 87(S): 3099. Ceramir Crown & Bridge was previously called XeraCem.

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A Permanent and Stable Seal
▶PROVEN! Superior marginal integrity[1]

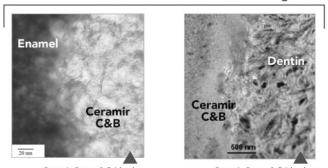
Ceramir Crown & Bridge has a unique capacity to create a marginal seal that will not degrade over time.

Unlike all other cements:

- High pH creates an environment that supports self-sealing properties
- Integrates completely with the tooth structure and creates a seamless interface between tooth and cement
- Successfully integrates with all irregularities on the contact surface
- Maintains an alkaline environment to resist acid and bacterial decay

1 Jefferies SR, Pameijer CH, Appleby D, Boston D, Galbraith C, Lööf J, Glantz P-O.Prospective Observation of a New Bioactive Luting Cement: 2-Year Follow-Up.J Prosthodont. 2012;21:33-41.

Seamless Nano-structural Integration



Ceramir Crown & Bridge has integrated with enamel in vivo.

Ceramir Crown & Bridge has integrated with dentin in vitro.

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Ceramir C&B combines glass ionomer technology with innovative Ceramir (Calcium Aluminate – CA) technology.

The GI contributes to:

- ***Low initial pH, short duration***
- ***Flow and Setting characteristics***
- ***Early strength***

The CA contributes to:

- ***Increased strength and retention***
- ***Biocompatibility***
- ***Sealing of tooth material interface***
- ***Apatite formation***
- ***Sustained long term properties, no degradation***
- ***Basic end pH***

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Ceramir® Crown & Bridge - Indications

Ceramir Crown & Bridge is indicated for permanent cementation of:

- ***Porcelain fused to metal crowns and bridges***
- ***Metal (gold, etc.) crowns and bridges***
- ***Gold inlays and onlays***
- ***Cast or prefabricated metal posts***
- ***Lithium Disilicate (E.max) > 1mm thickness***
- ***Strengthened core all-zirconia or all-alumina ceramic crowns and bridges***
- ***Full Coverage CAD/CAM chairside milled restorations***

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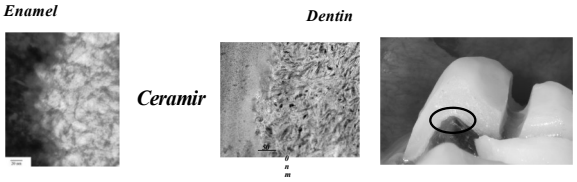
Benefits of Ceramir Crown and Bridge

- ***Sealed interface – less risk of secondary caries***
- ***Basic pH, chemical stability and no shrinkage gives a stable interface***
- ***Microcrystals integrate with and form apatite***



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Ceramir® Crown & Bridge - Permanent sealing

- ***Nanostructural integration with tooth and prosthetic material***
- ***Driven by the natural chemistry of the human body (same principal as natural remineralization)***
- ***Totally sealed interface between prosthetic material and tooth***
- ***Minimal microleakage***
- ***Acid resistance and long-term sealing of the prepared tooth***

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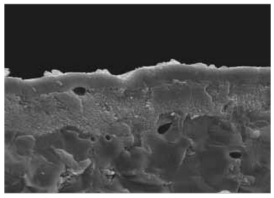
Bioactivity – Self Sealing Properties

Ceramir C&B is bioactive, enabling the formation of a surface layer of hydroxyapatite crystals. Clinically, this may translate into a protective hydroxyapatite layer at the tooth-restoration interface*



In saliva Ceramir C&B promotes HA formation at its surface, and could be expected to promote natural HA formation at the restoration-tooth interface**

**A comparative study of the bioactivity of three materials for dental applications. Published by: J Lööf, F Svahn, T Jarmar, H Engqvist, CH Pameijer. Published as: Dental Materials (2008) 24: 653–659*

***Hydroxyapatite formation on a novel dental cement in human saliva. Published by: J Engstrand, E Unosson, H Engqvist. Published as: ISRN Dentistry (2012): Article ID 6224056*

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RESEARCH ARTICLE

Preliminary Evidence That Bioactive Cements Occlude Artificial Marginal Gaps

STEVEN R. JEFFERIES, MS, DDS, PhD*, **ALEXANDER E. FULLER,** DMD†‡, **DANIEL W. BOSTON,** DMD§

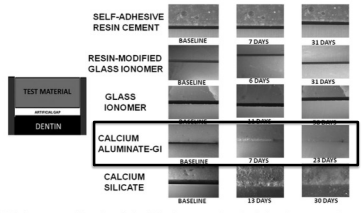

FIGURE 1. Basic experimental design for artificial gap (left) and microscopic photos of artificial gap changes over time during incubation in phosphate buffered saline (right).

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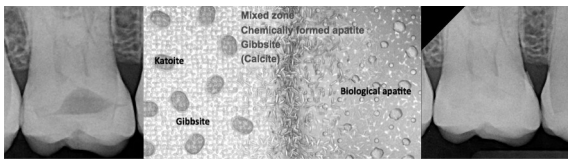
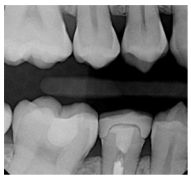
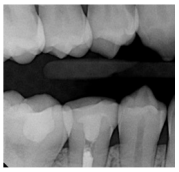




Sealing The Gap

"It's All About The Apatite!"



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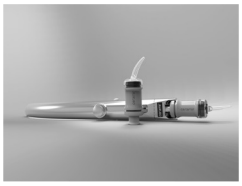

Ceramir C&B QuikCaps

- ***Have .17 ml of extruded material, vs. .11ml from the SingleCap***
- ***Are self-activated (no separate activator required)***
- ***Do not require turning of the nozzle after after mixing prior to extrusion***
- ***Works with more brands of applicators***

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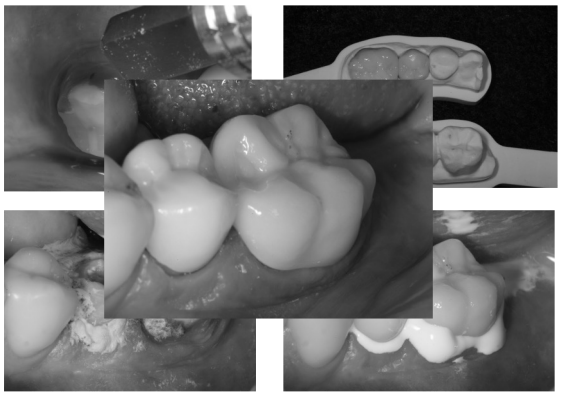

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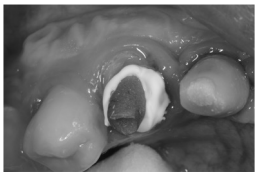

1 scoop of Ceramir C&B Powder to 2 drops of Ceramir C&B liquid

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Biocompatibility Studies *

- ***In comparison to all other direct dental materials***
- ***"Ceramir Crown & Bridge has excellent biocompatible properties"***
- ***"The ability to form hydroxyapatite contributes to the good tissue conserving properties"***

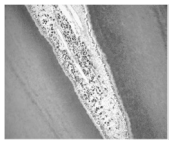

Figure 2. Group 1 – 85 days. Higher magnification of Figure 1 showing Ca aluminate capping material in pulp tissue. No inflammation. The material is dispersed in connective tissue of pulp without causing inflammation. (Tooth 1.1; 100X, H&E)

- ***Cornelis H. Pameijer DMD, DSc, PhD***
- ***Professor Emeritus University of Connecticut***

Expert report, Aug 2009

** Summarized in: Prof C.H. Pameijer CERAMIR™ CROWN & BRIDGE LUTING AGENT – A TREATISE ON BIOCOMPATIBILITY*

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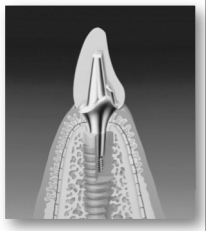
*Cementing With Ceramir Crown and Bridge on Implant Abutments**

- ***Cementing implant crowns with Ceramir C&B is a very good idea because…***
  - ***The viscosity of Ceramir C&B ensures easy seating even at extremely good fit***
  - ***The easy excess removal makes the procedure fast and clean***
  - ***The very high level of biocompatibility and tissue friendliness minimizes soft tissue reactions***



** These statements are based on cutstomer feedback*

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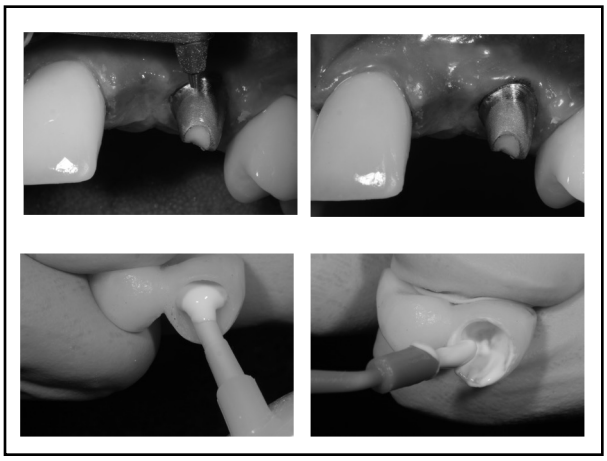

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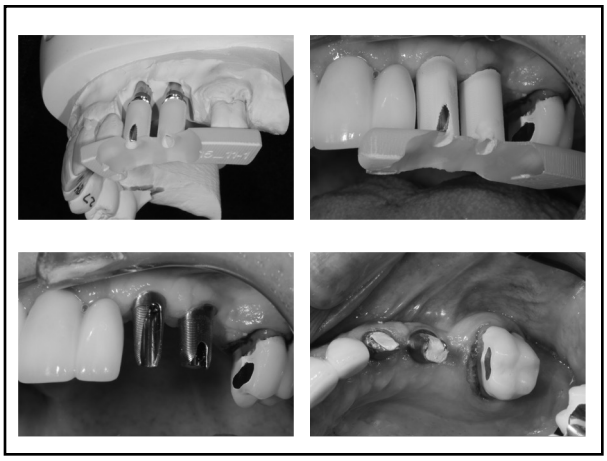

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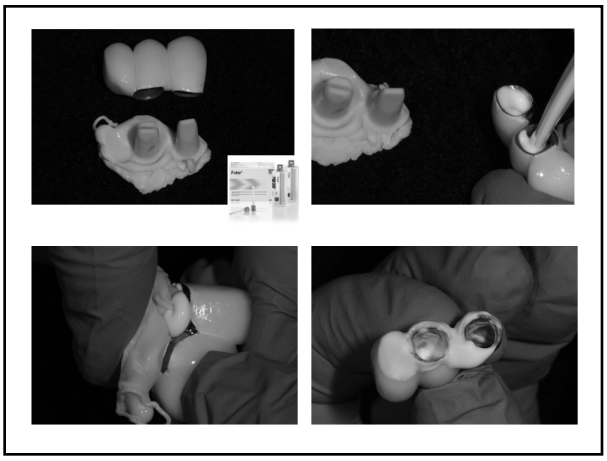

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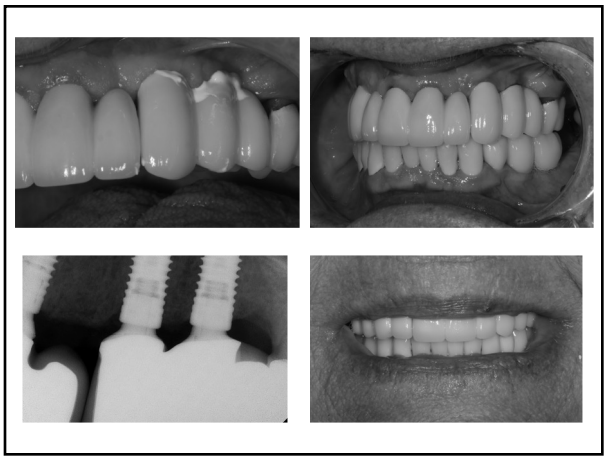

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Bioactive Resin Dental Cements

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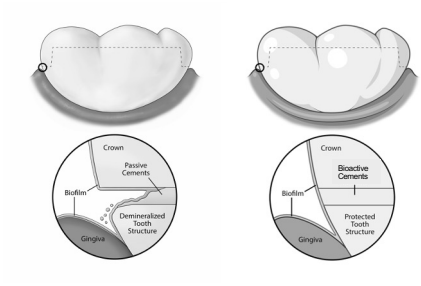

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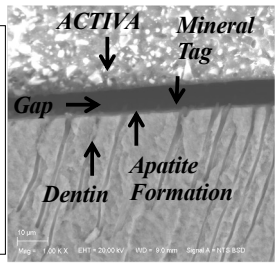
SEM Shows Apatite Formation & Marginal Seal:
The natural protective remineralization process

SEM shows cross section of dentin and ACTIVA BioACTIVE Cement

Green indicates the ACTIVA layer.
Red indicates the dentin.
Orange indicates the gap space produced when the specimen was fractured.
Purple shows the thin layer of apatite formation covering and penetrating the dentin tubules.
Blue indicates the formation of mineral apatite tags into the dentin tubules.



University testing submitted to IADR

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TheraCem®

A dual-cured, calcium and fluoride-releasing, self-adhesive resin cement indicated for luting crowns, bridges, inlays, onlays and posts (prefabricated metal/non-metal/fiber posts).

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TheraCem

- ***Calcium and Fluoride Releasing***
  - ***continuous ion release***
- ***Alkaline pH – buffers acid attack***
- ***High degree of conversion – high physical strength***
- ***Strong bond to Zirconium and High Strength Ceramics***

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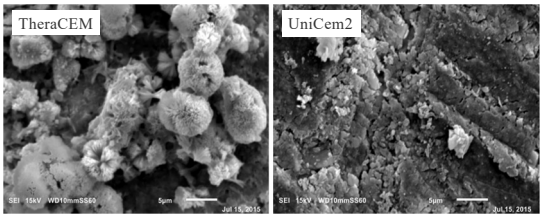
Apatite Formation With TheraCem – SEM Study

Representative SEM images of cement surfaces of after 7 months in PBS (phosphate buffered saline)



Chen L, Gleave C, Suh BI. IADR 2016 (#0280)

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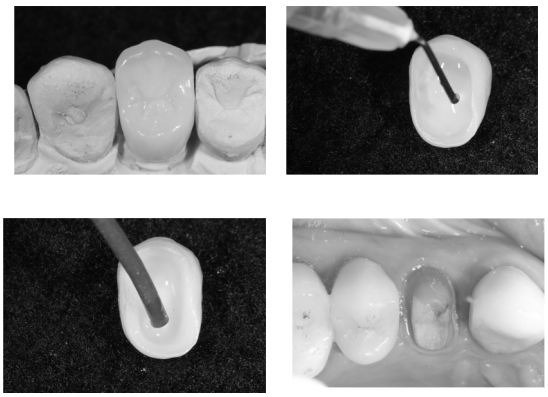

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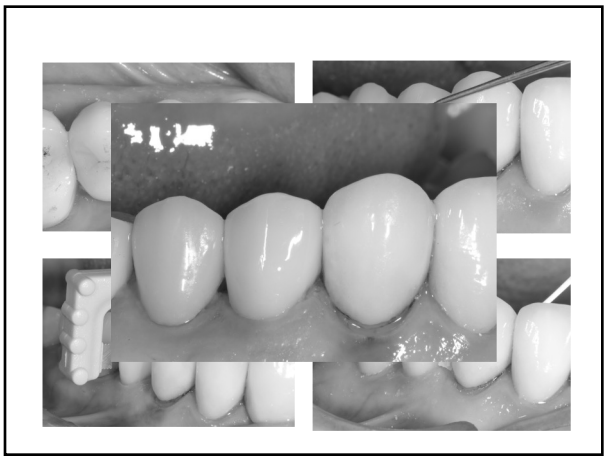

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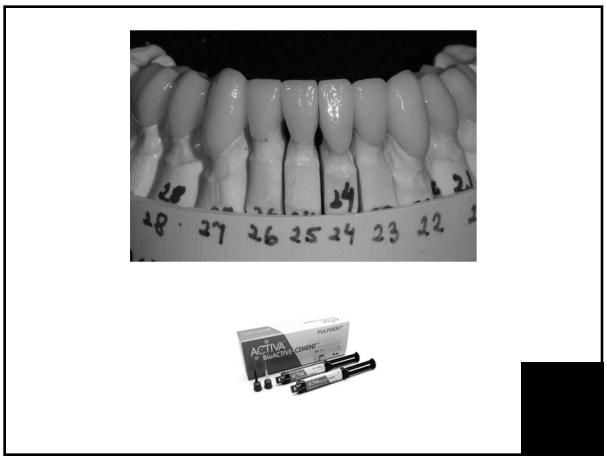

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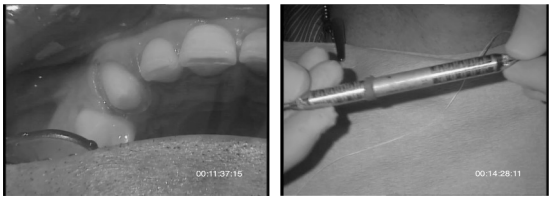

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Why is the Future Bioactive ?

Jack L. Ferracane, PhD
Department of Restorative Dentistry
Oregon Health & Science University

Dent Clin North Am. 2017 Epub
2017 Jul 29.
Biomaterials for Oral Health

In the future, the desire for a biomaterial to be inert and non-harmful to the patient, while still relevant and necessary, will no longer be considered sufficient. New materials, currently being introduced, under development, or simply envisioned, are expected to be bioactive, in that they will be intended to interact in some positive way with the oral environment. These materials will provide a wide range of diverse functions, including the routine inhibition of bacterial biofilm formation, remineralization of lost dentin and enamel, and the regeneration of diseased pulp, bone, and soft tissues.

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