

Calcium Phosphate Ion Clusters (CPICs)

An Exclusive Pac-Dent Biomimetic Enamel Support Technology

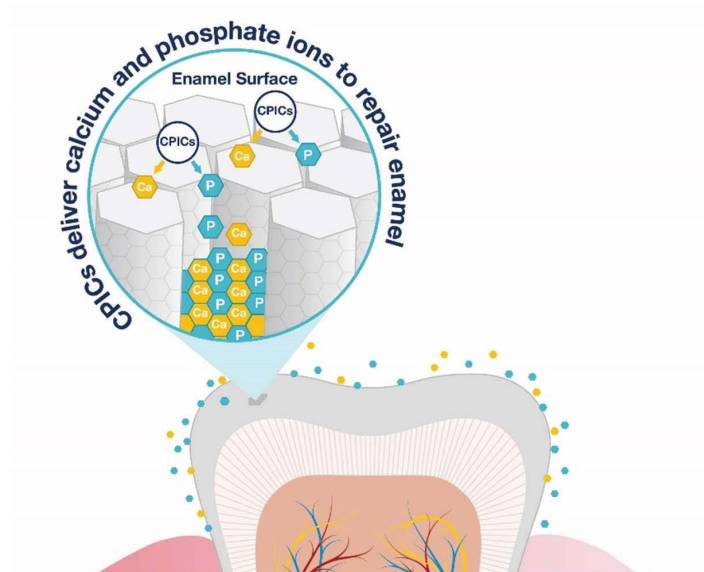
Features of Calcium Phosphate Ion Clusters

- **Supports enamel and dentin subsurfaces remineralization—not just the surface** Bioactive CPICs support biomimetic mineral regrowth that help remineralize demineralized enamel and supports repair of dentin subsurfaces and tubules.
- **Nano-cluster size enables deep subsurface penetration** Sub-2 nm calcium phosphate ion clusters diffuse into microscopic pores and defects before crystallizing, supporting remineralization of the enamel substructure rather than a simple surface coating.
- **Supports dentinal tubule remineralization to help manage sensitivity** When applied to exposed dentin, CPIC systems form a continuous mineral layer that helps seal and narrow dentinal tubules, helping to reduce fluid movement associated with hypersensitivity.
- **Provides calcium, phosphate, and fluoride to help support enamel mineral balance** In fluoride-containing formulations, CPIC-based pastes deliver calcium, phosphate, and fluoride ions directly to tooth surfaces to help support enamel mineral balance, particularly in patients at increased risk of demineralization.

Introduction

Dental caries, erosion and mechanical wear are among the most common causes of tooth structure loss worldwide. Many existing products focus on slowing further damage, but rebuilding what has already been lost—especially the intricate structure of enamel and the underlying dentin—has remained a major challenge.

Enamel's exceptional hardness and resilience come from its complex, interwoven hydroxyapatite crystal rods, which form a distinctive “fish-scale” pattern. Beneath the enamel, dentin contains a dense network of collagen and fluid-filled tubules that can become exposed and sensitive as mineral is lost.



Pac-Dent has introduced an advanced, biomimetic solution that targets this problem from the nanoscale upward: Calcium Phosphate Ion Clusters (CPICs).

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An Innovative Solution: CPICs

CPICs are engineered to mimic the body's natural mineralization processes, providing a highly bioavailable source of calcium and phosphate compared to many traditional calcium phosphate technologies.

These clusters exist as nanoscale prenucleation units of calcium and phosphate that:

- Penetrate into the microscopic pores and subsurface defects of demineralized enamel.
- Infiltrate the superficial dentin surface and dentinal tubules in appropriate formulations.
- Then transform into enamel-like apatite, supporting a continuous mineral phase.

When introduced into the oral environment, CPICs release calcium and phosphate ions in a controlled manner at the tooth surface. This ensures ions are available exactly where they are needed to support remineralization.

The newly formed mineral integrates with the existing tooth structure, helping restore mechanical properties such as hardness and elastic modulus toward those of sound enamel and dentin.

Scientific Research

A 2019 study from Zhejiang University compared calcium phosphate ion clusters (CPICs) with amorphous calcium phosphate (ACP) nanoparticles for enamel repair. Within 48 hours, CPICs regenerated enamel with an architecture that was indistinguishable from natural enamel under SEM and AFM, including repair of both enamel rods and inter-rod regions¹. Mechanical testing showed that the repaired layer had hardness and elastic modulus comparable to original enamel, whereas ACP nanoparticles produced a weaker, less organized layer.

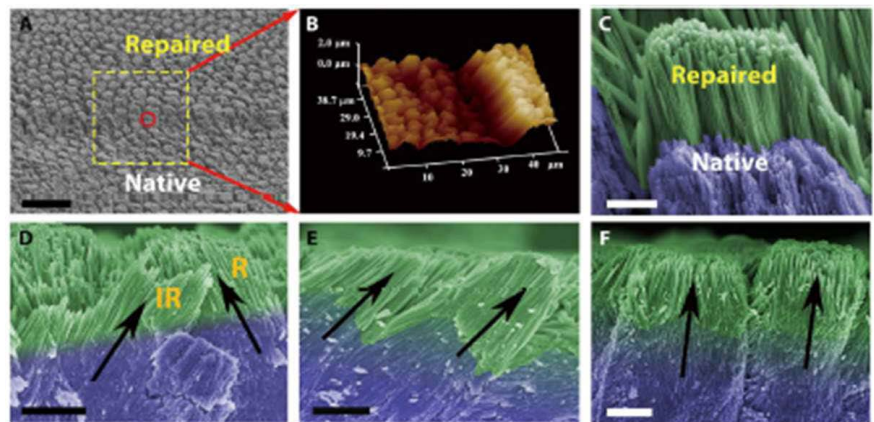


Figure 1. Replication of the complicated structure of enamel. (A) SEM image of both acid etched and repaired enamel. (B) A 3D AFM image of repaired enamel. (C) High-magnification SEM image of the red circle in (A). (D) Cross-sectional view of final repaired enamel, where both enamel rods and inter-rods were repaired. R and IR represent for enamel rod and interrod, respectively. (E and F) Enamel rods with different orientations can be repaired.¹

A 2022 study conducted a similar experiment to evaluate enamel hardness before and after treatment with a CPIC solution. Following CPIC application, the enamel hardness significantly increased, reaching levels comparable to that of natural tooth enamel². In contrast, treatment with polymer stabilized ACP nanoparticles was shown to reduce the mechanical strength of the repaired enamel³.

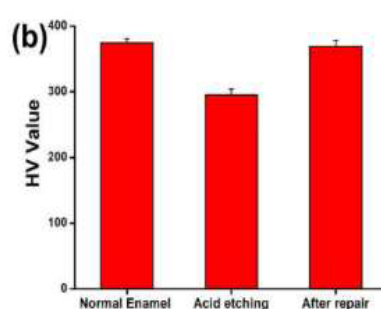


Fig 2. Vickers hardness values of normal enamel, enamel after acid etching for 10 min, and enamel after acid etching and repair with CaP Nanoclusters.²

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Beyond enamel, newer work has extended this ion-cluster concept to dentin. In an advanced dentin model, calcium phosphate oligomer systems closely related to CPICs rapidly formed a continuous mineral layer that penetrated several microns into dentinal tubules and the collagen matrix, creating a strong organic-inorganic interface and sealing tubules in vitro and in vivo⁴.

Preventive Products with CPIC Technology

Inspired by this CPIC platform, Pac-Dent developed ProMin and ProMin F, advanced remineralizing and desensitizing tooth pastes.

- ProMin and ProMin F harness CPIC nanotechnology to help support remineralization of demineralized enamel subsurfaces and support dentin tubule remineralization for sensitivity management.
- The paste can be applied with a toothbrush, fingertip, or custom tray, making it suitable for both professional and at-home protocols.

ProMin and ProMin F are appropriate for both children and adults when used as directed. They are designed to:

- Support enamel & subsurface remineralization
- Assist in managing hypersensitivity after professional cleanings or whitening.
- Support mineral balance & remineralization around orthodontic appliances & white-spot lesion risk areas.
- Support enamel in patients with tooth wear, or other sensitivity-prone conditions.



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ProMin F: Support for Patients with Reduced Salivary Flow

ProMin F is the fluoride-containing version of the paste and is particularly suitable for patients with reduced salivary flow. In these patients, saliva provides less calcium, phosphate and buffering capacity, so enamel is more vulnerable to ongoing acid challenges and demineralization.

ProMin F is formulated to deliver calcium, phosphate and fluoride directly to the tooth surface in a stabilized paste. This helps:

- Support enamel mineral balance when saliva alone may be insufficient.
- Provide ongoing support for patients at higher risk of demineralization and sensitivity, such as those with xerostomia or undergoing intensive restorative/orthodontic treatment.

ProMin is available in both fluoride-free (ProMin) and fluoride-containing (ProMin F) versions. For added convenience, ProMin F is also offered in a travel-friendly pen format for quick, targeted application to areas of concern.



References:

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3. Tang, S., Dong, Z., Ke, X. et al. Advances in biomineralization-inspired materials for hard tissue repair. Int J Oral Sci 13, 42 (2021). <https://doi.org/10.1038/s41368-021-00147-z>
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