Ceramir Protect LC – combining the unique Ceramir technology with a light cured matrix

The calcium phosphate mineral hydroxyapatite is one of the main building blocks of both dentin, and enamel, and is a vital part in proving the activity of a dental material. The unique Ceramir technology has as the only dental material system proven hydroxyapatite growth on the material surface using advanced material characterization techniques. The characterization of Ceramir has combined mineral specific techniques, such as X-ray diffraction (XRD), with imagining techniques, such as scanning electron microscopy (SEM), transmission electron microscopy (TEM), and X-ray photoelectron spectroscopy (XPS or ESCA). [1-3]

Ceramir Protect LC release both calcium and hydroxyl ions, utilizing the well-known mechanics of calcium hydroxyl agents for pulp capping. Calcium hydroxyl is known to stimulate dentin formation over open pulp and is frequently used as pulp capping agent in various forms. The effect of calcium hydroxide on dental pulp has been shown by i*n vitro* studies where dental pulp stem cells (DPC) increased cell growth and started secreting dental mineral in the presence of calcium hydroxide [4].

Dentin mineralization

For a material to induce dentin mineralization three main components are needed; phosphate ions, calcium ions and an alkaline pH. Phosphate ions are readily available in all body fluids in large amount. Calcium ions, on the other hand, are available, but only in low concentrations. To have dental mineral formation calcium ions are needed to be supplied from the dental material. Although physiological pH is not bad for mineral growth, dental mineral is most stable at alkaline pH [5]. Alkaline pH has also proven to increase the growth and proliferation of DPCs [6]. Per definition, increased pH is caused by an increased hydroxyl ion concentration. Pulp capping materials releasing calcium and hydroxyl ions hence give the dental pulp vital prerequisites for new dentin formation.

Calcium release and pH measurement

The calcium release as well as the effect on pH of Ceramir Protect LC were tested similarly to previously published data for calcium hydroxide and calcium silicate pulp capping agents [7]. Results from the calcium release presented in Figure 1 show that Ceramir Protect LC release about twice the amount of calcium as TheraCal LC (Bisco Inc., USA), and Dycal (Dentsply Sirona, USA). In addition, the two other compared products (Lime-lite, PulpDent, USA and Bio-Cap, Den-Mat Holdings LCC, USA) showed close to no calcium release during the four-week measurement. Ceramir Protect LC was further able to increase the pH of distilled water to 11.6 after seven days of storage, which was higher than all compared products (TheraCal LC 10.9, Dycal 11.0, Bio-Cap 5.6, and Lime-lite 5.6).

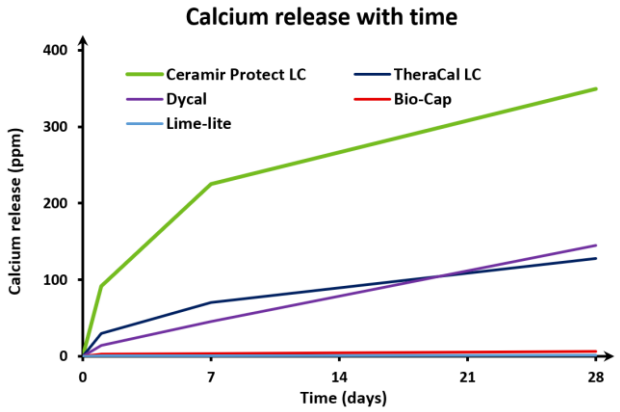

Figure 1. Calcium release during water storage at 37°C for up to four weeks. Data collected by Lawson, University of Alabama at Birmingham.

Surface mineralization

Surface mineralization qualitatively show if the material can induce hydroxyapatite growth. If mineralization is performed in phosphate buffered saline (PBS) with no added calcium or magnesium ions, calcium containing mineral (hydroxy-apatite) can only be formed if calcium is released from the material. Furthermore, if the material release hydroxyl ions and therefore can increase the pH of the surrounding solution, the calcium-phosphate mineral formed will have all prospects to precipitate as hydroxyapatite mineral.

Electron images of the material surface after PBS storage for one week show a clear surface mineralization. A thick layer with needle like mineral is clearly visible (Figure 2). Typically, hydroxyapatite precipitate as needles, as this is the most energetically favoured way of precipitation, showing that the precipitated layer is indeed hydroxyapatite.

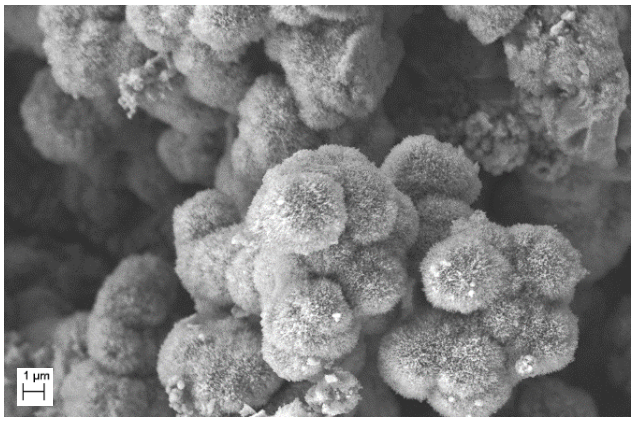

Figure 2. SEM micrographs showing Ceramir Protect LC after storage in PBS solution for seven days.

References

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