



## Recent Review of Calcium Silicate-Based Sealers

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### Abstract

The purpose of this review is to evaluate manufacturer's recommendations and the results of *in vitro* experimental studies carried out in the case of five bioceramic-based root canal sealers: AH Plus Bioceramic Sealer (Dentsply Sirona), Total Fill BC Sealer (FKG), NeoSealer Flo (Avalon Biomed), CeraSeal (Meta Biomed) and Bio-C Sealer (Angelus). Bioceramics materials have a very good tissue biocompatibility, due to their similarities with hydroxyapatite, being able to induce tissue regenerative response.

**Keywords:** Bioceramic-Based Sealers; Bioactive Materials; Flowability; Radiopacity; Material Properties

### Introduction

Advances in endodontic materials developments are constantly changing the field of endodontics. Over the last thirty years, the researchers have focused on developing bioactive materials that can interact and induce regeneration of the surrounding tissues. It all started in the 1990's, when a new group of materials called bioceramics was introduced in endodontics [1]. These materials were first introduced as retrograde filling materials and then as root repair cements, root canal sealers and coatings for gutta-percha cones [3].

According to the interaction with surrounding tissues, bioceramic materials can be classified as [2,4]:

- Bioinert - non interactive with biological systems (alumina, zirconia)
- Bioactive - durable tissues that can undergo interfacial interactions with surrounding tissue (calcium silicates, bioactive glass, bioactive glass ceramic, hydroxyapatite)
- Biodegradable - eventually replaced or incorporated into tissue (calcium phosphate, bioactive glass)

**Bioceramic-based root canal sealer**

The first generation bioceramic cement introduced in endodontics is mineral trioxide aggregate (MTA), a medical mixture of sterile Portland cement and bismuth oxide, with excellent biocompatibility and sealing abilities [5].

To avoid tooth discoloration, in 2002 is introduced white MTA by decreasing the concentrations of iron, aluminum and magnesium oxides [5]. It is the most studied bioceramic material in endodontics, with predictable outcomes in the root canal treatment [6].

The applications of MTA in endodontics are multiple and varied, from pulp capping to retrograde filling [7,8]. Unfortunately, it can not be used as an endodontic sealer in it’s pure form because of it’s inability to flow adequately in the canal.

Over the last decades, endodontic sealers based on the properties of calcium silicate cements have been introduced. Unlike conventional root canal sealers, these materials exhibit biocompatibility, bioactivity and antimicrobial properties [9,10]. For marketing purposes, these sealers are usually called “bioceramics”, but the term is not accurate at all because bioceramics include a vast category of materials which are different in terms of chemical composition. So, for the sealers based on calcium silicate, the correct term should be “calcium silicate-based sealers” (CBSC) or “hydraulic calcium silicate-based sealers”, due to their chemical composition and hydraulic setting reaction [11,12].

The first calcium silicate-based sealer, iRoot SP (Innovative, Bioceramix, Vancouver, Canada), was introduced in 2007 [13]. Nowadays, there is a move towards using bioceramic root canal sealers such as AH Plus Bioceramic Sealer, Total Fill BC Sealer, NeoSealer Flo and others. We evaluated the chemical composition and properties of five calcium-silicate based sealers included in the table 1 below.

**AH Plus Bioceramic Sealer**

Bioceramic Sealer Ah Plus is derived from mineral trioxid aggregate (MTA) and together with the guttapercha cone is used in root canal filling. Because it’s provenance, it has the ability to release calcium ions and produce an apatite layer in the presence

Brand name	Manufacturer	Components
AH Plus Bioceramic Sealer	Dentsply Sirona	Zirconium dioxide, tricalcium silicate, dimethyl sulfoxide, lithium carbonate, thickening agents
Total Fill BC Sealer	FKG	Calcium silicates, calcium phosphate monobasic, zirconium oxide, tantalum oxide, thickening agents
NeoSealer Flo	Avalon Biomed	Tantalite, tricalcium silicate, calcium aluminate, dicalcium silicate, tricalcium aluminate, calcium sulfate
CeraSeal	Meta Biomed	Tricalcium silicates, dicalcium silicates, calcium aluminates, zirconium oxides, thickening agents
Bio-C Sealer	Angelus	Tricalcium silicate, dicalcium silicate, calcium aluminate, zirconium oxide, thickening agents

**Table 1**

of phosphate-containing physiological fluids [14-16], resulting a product with an excellent ability to seal and biocompatibility. It comes in a pre-mixed syringe that can be placed directly into the root canal. Regarding this, it doesn’t need powder/liquid or base/catalyst mixing to set, because of it’s property to absorb the tissue’s moisture.

**The manufactured product contains:**

- 5-15% tricalcium silicate as core material and responsible for setting of the sealer
- Zirconium dioxide as radiopacifier
- Dimethyl sulfoxide (DMSO) as non-reactive diluent to convey suitable flow properties of the paste
- Lithium carbonate to support the setting and other ingredients : bentonite clay, polyvinyl alcohol and polyvinyl pyrrolidone.

When it comes to radiopacity, Bioceramic Sealer Ah Plus outperforms other evaluated calcium silicate-based sealers. In addition, the film thickness and flowability have improved, which

facilitates his capacity to penetrate into dentinal tubules and to seal complex anatomies. AH Plus Bioceramic Sealer has similar final setting time compared to CeraSeal in 720 +/- 60 min. NeoSealer Flo show the longest final setting time (significant difference with other evaluated sealers) above 1300 min [17].

Comparing this sealer to other calcium silicate-based sealers with a higher tricalcium silicate concentration, the amount of calcium release is comparable [17].

### Total fill BC sealer

According to the manufacturer, Total Fill BC contains : zirconium oxide, calcium silicates, calcium phosphate, calcium hydroxide, filler and thickening agents.

Total Fill BC Sealer uses the moisture present in the dentinal tubules to initiate the setting reaction, also engaging a reaction between the two components, calcium phosphate and calcium hydroxide, producing hydroxyapatite [18] to improve the setting phase and also to ensure an excellent bond to both the dentin and the filling material.

Other clinical advantages are increasing fracture resistance, limited microorganism growth and conservative canal preparation.

The setting time is 4 hours but in very dry root canals it increases up to more than 10 hours.

Total Fill BC sealer is highly radiopaque and hydrophilic.

### Neosealer Flo

NeoSealer Flo is a premixed bioceramic sealer.

The product is composed of :

- Tricalcium silicate (<25%) and dicalcium silicate (<10%) as bioactive components
- Calcium aluminate (<25%)
- Calcium aluminum oxide (grossite) (<6%)
- Tricalcium aluminate (<5%) and tantalite (50%) as radiopacifier.

Traces of calcium sulfate (<1%) are also reported by the manufacturer.

Larger solubility, open pore capacity, and water absorption were demonstrated by NeoSealer Flo and AH Plus Bioceramic, which may have led to potentially larger ion release [17].

Due to the possibility of tooth discoloration and the toxicity of bismuth when it comes in contact with periapical tissues, bismuth oxide was excluded from the composition [18].

The fine sizes of particles helps the bioceramic sealer to flow and seal complex anatomies, such as lateral canals, and to coat uniformly the canal walls and gutta-percha.

According to dimensional stability test ADA 57, root canal sealers must have  $\leq 1\%$  shrinkage and  $\leq 0.1\%$  expansion, Neosealer Flo has 0.08 % expansion.

NeoSealer Flo has the longest setting time > 7h.

### CeraSeal

CeraSeal is a premixed bioceramic sealer including tricalcium silicate (20–30%) and dicalcium silicate (1–10%) as bioactive components, and tricalcium aluminate (1–10%) and zirconium dioxide (45–50%) as radiopacifiers. According to the manufacturer it has exceptional stability but lower radiopacity and similar flowability when compared to AH plus [17].

CeraSeal has the shortest setting time (3.5 hours) than any other bioceramic-based root canal sealer, therefore preventing the wash-out phenomenon.

pH : 12,7 meaning excellent biocompatibility.

CeraSeal doesn't expand, nor shrinks in the root canal.

### Bio-C sealer

Bio-C Sealer by Angelus is a 100% bioceramic, non-resinous root canal sealer ready to use. Its viscosity is given by a long-chain alcohol, the polyethylene glycol. Therefore, the product is more biocompatible and easier to clean.

Manufacturers allow us to use Bio-C Sealer together with gutta-percha heating technique, the maximum temperature reached by the equipment is 200°C. The Bio-C sealer is stable at this temperature, unlike some other root canal sealers that degrade at temperatures close to 144°C.

The setting time is  $\leq 4$  hours.

Zordan-Bronzel, *et al.* had concluded that in comparison with Total Fill BC Sealer and Ah Plus Sealer, Bio-C Sealer showed a short setting time, alkalization ability, and adequate flow and radiopacity as well as low volumetric change. However, this sealer had higher solubility than the rates required by ISO 6876 standard [19].

## Conclusions

The purpose of this review is to present the biosealer properties and the clinical implications, helping the clinician to make an appropriate choice.

Future clinical studies would be necessary to strengthen the arguments for the new materials.

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