Sol-gel Synthesis of Zn-doped Bioactive Endodontic Cements: Effect of Zn Content on Crystal Phase Formation

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Introduction

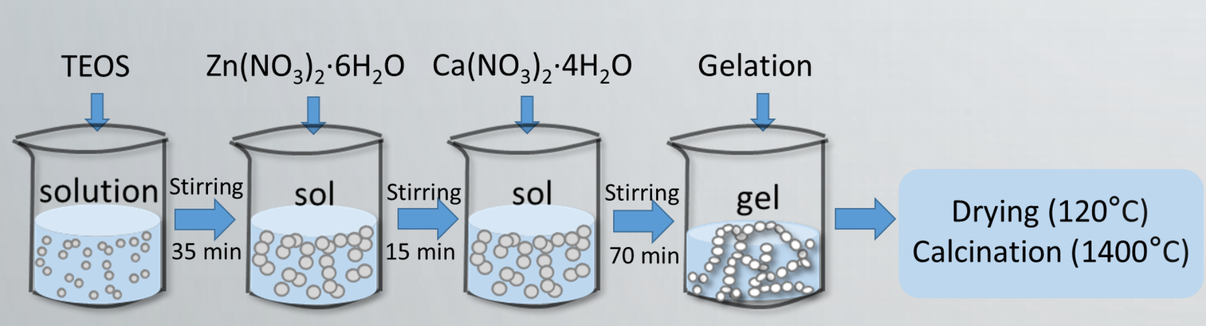
Bioactive endodontic cements (BECs) are widely used in endodontics for root filling materials, pulp capping materials, root perforation repair, apexification and coronal sealing during regenerative endodontic procedures [1]. BECs are mainly composed of tricalcium silicate (Ca_3SiO_5) and dicalcium silicate (Ca_2SiO_4) phases, which behave hydraulic after mixing with water and have good sealing abilities. The sol-gel process is a chemical synthesis technique which in comparison with high temperature procedures has several advantages. The liquid media provides a molecular level reaction of the precursors, a greater homogeneity of the final products as well as the generation of a large number of nano-pores and very high specific surface area [2]. Zinc (Zn) is an element of particular interest in dentistry due to its antibacterial activity as well as the biological effects in stimulating cell proliferation and differentiation. Zn increases mineralization by stimulating alkaline phosphatase (ALP) and type I collagen.

Objectives

- Synthesis of Zn-doped BECs ranging from 1 to 5 mol.% using the sol-gel technique & preliminary characterization of the crystalline phases formation and setting time performance.

Materials and methods

Synthesis route



Characterization

- X-ray diffraction (XRD) was applied to analyze the crystalline phases composition.
- The Gillmore needles test was applied to measure the setting time according to ASTM C266 specifications.

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Results

Crystalline phases characterization

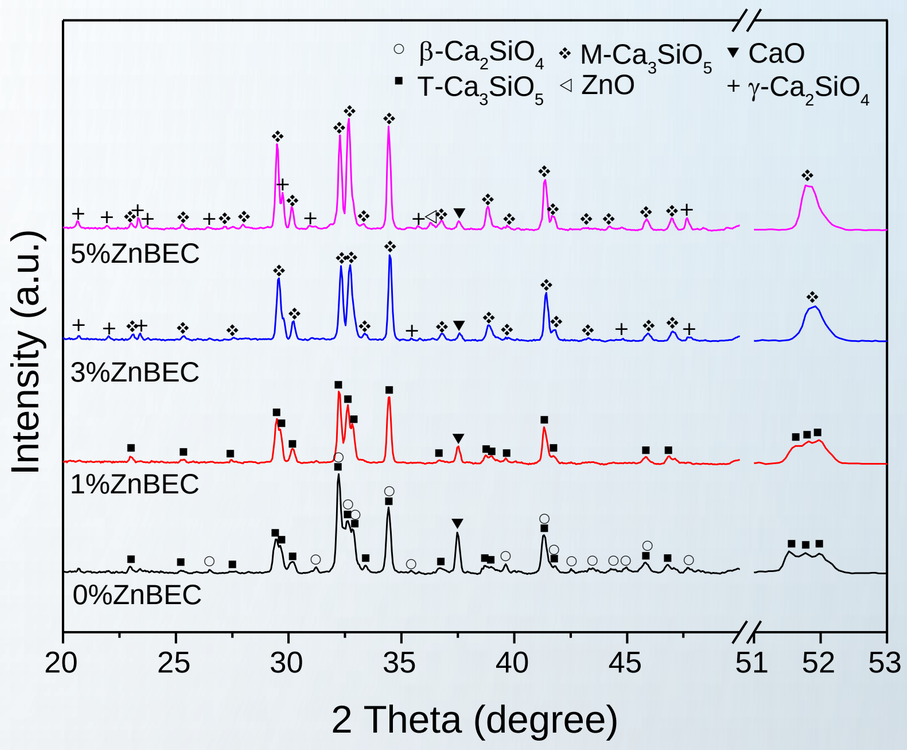

Figure 1. XRD patterns of BECs doped with different Zn content.

Setting time performance

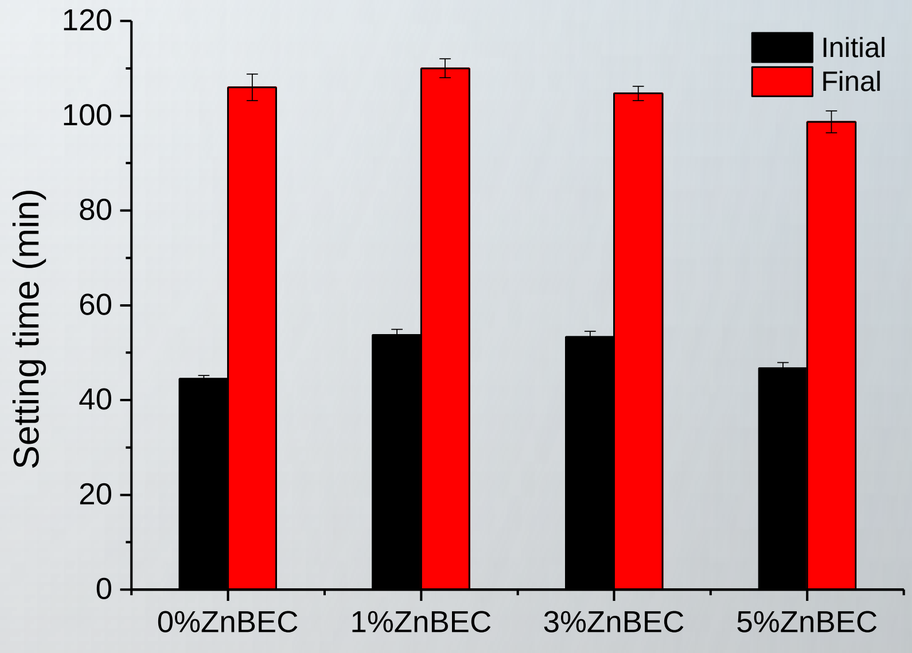

Figure 2. Setting time of BECs doped with different Zn content.

Conclusions

- ✓ XRD results indicate that the Zn incorporation has an effect in tricalcium silicate crystallization; Increasing Zn content up to 5 mol.% promotes the stabilization of the monoclinic polymorph.
- ✓ Setting time tests show there are no significant differences between the setting time of the samples with different Zn content.

References

[1] C. Prati, M.G. Gandolfi, *Dent. Mater*. 31 (2015) 351.
[2] X. Song, A. Díaz-Cuenca, *Materials* 15 (2022) 6051.