Effect of substitution amount of magnesium and zinc on dissolution behaviour and thermal properties of Bioglass 45S5

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Abstract

This study investigates the effect of Mg or Zn for Ca substitution (2.5, 5, 7.5, 10, 15, 25, 50, 75 and 100%) on thermal and dissolution properties of Bioglass 45S5 (46.1 SiO2-2.6 P2O5-26.9 CaO-24.3 Na2O; mol%). Glasses were prepared by a melt-quench route, and their thermal properties were characterised by dilatometry and DSC. Glass transition temperature (Tg) showed a decrease with Mg or Zn for Ca substitution up to 75 %. Surprisingly, complete substitution of Mg or Zn for Ca led to a rise of Tg. Owing to higher field strengths of Mg and Zn compared to Ca an increase in Tg is expected, whereas the results suggested a mixed cation effect. Crystallisation temperature increased with increasing substitution, resulting in an increased processing window of partially substituted Bioglass and improved glass formation. To study the ion release behaviour, glass powder was immersed in tris(hydroxymethyl)aminomethane (Tris) buffer solution for up to 3 days. FTIR spectra of treated glass powders showed that only glasses with low Mg substitution (up to 25 %) or very low Zn substitution (2.5%) formed crystalline hydroxyapatite. The spectra of glasses with higher Mg substitution showed broad bands indicating amorphous apatite formation, while those of glasses with higher Zn substitution no characteristic hydroxyapatite bands were found. Comparing both glass series revealed that thermal properties were affected by Mg and Zn substitution in a similar way, whereas the dissolution behaviour differed significantly, despite similarities in ionic radius and size of Mg and Zn ions.

Keywords: Bioglass, Magnesium, Zinc, dissolution properties, thermal properties

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