Microstructure Development and In vitro dissolution behavior of SiO_2–MgO–Al_2O_3–K_2O–B_2O_3–F glass–ceramics

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Abstract

The present work demonstrates how crystals with two different characteristic morphologies can be formed in SiO_2–MgO–Al_2O_3–K_2O–B_2O_3–F glass-ceramic system by adopting two sets of heat treatment experiments. In our study, single stage heat treatment experiments were performed at 1000^oC for varying holding time of 8–24 h with 4 h time interval and as a function of temperature in the range of 1000–1120^oC with 40^oC temperature interval. For temperature variation batches, the microstructure is characterized by interlocked, randomly oriented mica plates ('house-ofcards' morphology). An important and new observation of complex crystal morphology is made in the samples heat treated at 1000^oC for varying holding times. Such morphology appears to be the results of composite spherulitic-dendritic like growth of mica rods radiating from a central nucleus. Another important result is that a maximum of around 70% of spherulitic-dendritic like crystal morphology can be obtained after heat treatment at 1000^oC for 24 h, while a lower amount (~58%) of interlocked plate like mica crystals is formed after heat treatment at 1040^oC for 4 h.

In the next part of study, we report the results of the in vitro dissolution tests, which were carried out by immersing the selected glass–ceramic samples in artificial saliva (AS) for various time periods of up to 42 days. The bioactivity of the samples was probed by measuring the changes in pH, ionic conductivity and ionic concentration of AS following in vitro dissolution experiments. High resistance of the selected glass–ceramic samples against in vitro leaching has been demonstrated by minimal weight loss (<1%) and insignificant density change, even after 6 weeks of dissolution in artificial saliva. While XRD analysis reveals the change in surface texture of the crystalline phase, FT-IR analysis weakly indicated the Ca–P compound formation on the leached surface. The experimental measurements further indicate that the leaching of F^-, Mg^{2+} ions from the sample surface commonly causes the change in the surface chemistry. Furthermore, the presence of (Ca, P, O)-rich mineralized deposits on the leached glass–ceramic surface as well as the decrease in Ca^{2+} ion concentrations in the leaching solutions (compared to that in the initial AS solution) provide evidences of the moderate bioactive or mild biomineralisation behavior of investigated glass–ceramics.

References:

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