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Influence of Titanium Oxide on Crystallization, Microstructure and Mechanical Behavior of Barium Fluormica Glass-Ceramics

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Abstract : The galloping advancement of research work on glass-ceramics stems from their wide applications in electronic industry and also to some extent in application oriented medical dentistry. TiO2, even in low concentration has been found to strongly influence the physical and mechanical properties of the glasses. Glass-ceramics is a polycrystalline ceramic material produced through controlled crystallization of glasses. Crystallization is accomplished by subjecting the suitable parent glasses to a regulated heat treatment involving the nucleation and growth of crystal phases in the glass. Mica glass-ceramics is a new kind of glass-ceramics based on the system SiO2•MgO•K2O•F. The predominant crystalline phase is synthetic fluormica, named fluorophlogopite. Mica containing glass-ceramics flaunt an exceptional feature of machinability apart from their unique thermal and chemical properties. Machinability arises from the randomly oriented mica crystals with a 'house of cards' microstructures allowing cracks to propagate readily along the mica plane but hindering crack propagation across the layers. In the present study, we have systematically investigated the crystallization, microstructure and mechanical behavior of barium fluorophlogopite mica-containing glass-ceramics of composition BaO•4MgO•Al2O3•6SiO2•2MgF2 nucleated by addition of 2, 4, 6 and 8 wt% TiO2. The glass samples were prepared by the melting technique. After annealing, different batches of glass samples for nucleation were fired at 730°C (2wt% TiO2), 720°C (4 wt% TiO2), 710°C (6 wt% TiO2) and 700°C (8 wt% TiO2) batches respectively for 2 h and ultimately heated to corresponding crystallization temperatures. The glass batches were analyzed by differential thermal analysis (DTA) and x-ray diffraction (XRD), scanning electron microscopy (SEM) and micro hardness indenter. From the DTA study, it is found that the fluorophlogopite mica crystallization exotherm appeared in the temperature range 886–903°C. Glass transition temperature (Tg) and crystallization peak temperature (Tp) increased with increasing TiO2 content up to 4 wt% beyond this weight% the glass transition temperature (Tg) and crystallization peak temperature (Tp) start to decrease with increasing TiO2 content up to 8 wt%. Scanning electron microscopy confirms the development of an interconnected ‘house of cards’ microstructure promoted by TiO2 as a nucleating agent. The increase in TiO2 content decreases the vicker’s hardness values in glass-ceramics.

Keywords : crystallization, fluormica glass, ‘house of cards’ microstructure, hardness
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