Nucleation and crystallization of lithium silicate glass-ceramics: understanding of crack initiation

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Abstract

Glass-ceramics are polycrystalline materials produced by controlled crystallization of glasses, and their properties are strongly dependent on the crystallization rate. The control of both composition and (micro-)structural arrangements (e.g. crystal size, shape, and orientation) has led to several applications for these materials, such as kitchenware, dental applications, optical device, bioactive implants, etc... Li-disilicate (LS2) glass-ceramics show great potential, especially for dentistry applications, because of the good aesthetic, high fracture resistance and bonding durability. Lately, it has been demonstrated that crystallite orientation in LS2 glass-ceramics significantly affects crack resistance.
In this study, LS2 glass-ceramics were synthesized starting from a non-stoichiometric glass. The coefficient of thermal expansion and elastic constants of the parent glass were determined experimentally, while the influence of different nucleating/crystallization temperatures and times on crystalline phases, crystal morphology, and mechanical properties were evaluated for the glass-ceramic materials. Indeed, it was verified both by Raman and XRPD the different crystalline phases occurring depending on temperatures and dwell times, and moreover, by SEM images the crystal morphology and crystallite volume fractions for various phases were estimated for residual thermal stress calculations.
Theoretical models were used to estimate the mechanical properties, and the data were compared to the mechanical properties experimentally obtained on different commercial samples, typically used for dental prosthesis applications.

Keywords: lithium disilicate, microstructure, mechanical properties, dental prosthesis

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