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Effect of partial crystallization on hardness and fracture toughness of glasses from the system CaO.MgO.SiO_2

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Partial or full crystallization drastically modifies the microstructure of glasses leading to certain crystalline phases and morphologies that may result in improved mechanical properties. For biomedical materials for bone restoration, high toughness is an important requirement to reduce prosthesis failure after implantation. In this work, glass-ceramics containing wollastonite as the main phase were produced by double-stage heat treatments for crystal nucleation and growth. The treatment temperatures were selected after differential scanning calorimetry (DSC) analysis, varying from 600 to 950°C. The samples were characterized by X-ray diffraction. The effect of size, number and morphology of the crystals on hardness and indentation fracture toughness were determined by Vickers indentation. A glass-ceramic with hardness of 7.2 GPa and indentation toughness $K_{IC} \sim 1.2 \text{ MPa.m}^{1/2}$ was obtained. This value of K_{IC} represents an increase of about 50% when compared with the K_{IC} of the parent glass (0.8 MPa.m^{1/2}).