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Microstructure and mechanical properties of in-situ grown mullite toughened 3Y-TZP zirconia ceramics fabricated by gelcasting

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Abstract: In-situ grown mullite toughened zirconia ceramics (mullite-zirconia ceramics) with excellent mechanical properties for potential applications in dental materials were fabricated by gelcasting combined with pressureless sintering. The effect of sintering temperature on the microstructure and mechanical properties of mullite-zirconia ceramics was investigated. The results indicated that the columnar mullite produced by reaction was evenly distributed in the zirconia matrix and the content and size of that increased with the increase of sintering temperature. Mullite-zirconia ceramics sintered at 1500°C had the optimum content and size of the columnar mullite phase, generating the excellent mechanical properties (the bend strength of 890.4 MPa, the fracture toughness of 10.2 MPa·m^{1/2}, the Vickers hardness of 13.2 GPa and the highest densification). On the other hand, zirconia particles were evenly distributed inside the columnar mullite, which improved the mechanical properties of columnar mullite because of pinning effect. All of this clearly confirmed that zirconia grains strengthened columnar mullite, and thus the columnar mullite

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