02-062

Evaluation of reduced graphene oxide -reinforced zirconia ceramics processing conditions

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Yttria tetragonal zirconia polycrystal (Y-TZP) has been widely used as dental and orthopaedic implants. However, the lack of stability of the tetragonal phase in water environment can induce damages on the ceramic surface due to the transformation into the monoclinic phase. The reduction of ceramic grain size can avoid this phase transformation, despite the loss of transformation toughening benefits. In order to minimize this drawback, the incorporation of a second phase into the zirconia matrix has been recently considered. The aims of the present contribution were to establish the procedure of ceramic processing of reduced graphene oxide -reinforced zirconia ceramics and to verify its influence on hardness and fracture toughness. The composite production included several steps: (a) synthesis of Y-TZP powder by coprecipitation route, (b) synthesis of graphene oxide from chemical exfoliation of graphite (modified Hummer’s method) followed by reduction with ascorbic acid, (c) sonication of reduced graphene oxide in Y-TZP suspension followed by drying (d) uniaxial pressing and (e) sintering in a conventional tubular furnace (Argon/ 4%hydrogen atmosphere) and spark plasma sintering (SPS). The concentration of rGO in Y-TZP was fixed between 0.01 to 2.0 wt%. Sintered samples were characterized by X-ray diffraction, scanning electron microscopy, density measurements, and Vickers method for hardness and fracture toughness determination. Results showed that the procedure stablished for dispersion of rGO in Y-TZP allowed a good physical homogeneity of rGO and Y-TZP. Regarding the sintering procedure it was observed that conventional sintering in a controlled atmosphere was not effective for ceramic densification due to microcrack formation at the ceramic surface. Employing 0.05 rGO wt% in Y-TZP ceramic associated to spark plasma sintering at 1350oC allowed density higher than 98%DT and hardness and fracture toughness up to 14.4 GPa and 7.8 MPam1/2.