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Yttria stabilized zirconia formed by micro ceramic injection molding: Rheological properties and debinding effects on the sintered part

Abstract

Micro Ceramic Injection Molding (μCIM) is a near net-shape process to produce smaller and intricate parts at a competitive cost. The application of nano-sized ceramic powder in μCIM has the advantages of fine grain size growth and good surface finish. However, the nano size effect causes agglomeration and low powder loadings, which result in defects during the μCIM process and in the sintered components. This study extensively investigated the debinding and sintering of yttria-stabilized zirconia (YSZ), as well as its rheological properties, using polypropylene (PP) as the primary binder and palm stearin as the secondary binder. 50 nm Yttria stabilized zirconia (YSZ) powders were mixed with palm stearin and PP at a powder loading of 37–43 vol%. The results of rheological studies showed that the feedstock had a dilatant flow characteristic and a viscosity of around 10–40 Pa s. Feedstock with 38 vol% powder loading had the lowest activation energy of 9.48 kJ/mol. The green part of the injected feedstock had flexural strength ranging from 13 to16 MPa, within which the feedstock with 43 vol% powder loading had the highest green density. Solvent debinding was carried out at three temperatures (50, 60, and 70 °C) using heptane. A large porous region was clearly identified at 70 °C compared with 50 °C. A debinding split furnace with argon gas was used to remove PP at 450 °C for 4 h. The debound samples did not shrink when 94%–98% of the binder system was removed. All debound samples sintered at 1350 °C and 41 vol% had the highest mechanical properties with hardness of 900 HV and a flexural strength of 400 MPa.

Keywords; Mechanical properties, Micro ceramic injection molding (μCIM), Nano sized zirconia, Rheological properties