Electric field-assisted sintering of yttria-stabilized zirconia: dependence on the frequency and the current density

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ZrO_2:3 mol% Y_2O_3 green pellets were sintered by applying AC electric fields (0.5-1.1 MHz, 100/200 $V.cm^{-1}$, 20-120 $mA.mm^2$) at T<1200°C (first stage sintering). Similar specimens reached shrinkage levels dependent on the frequency of the applied field, suggesting that the Joule heating imparted to the specimen depends on the number of collisions of charge carriers with chemical species at the intergranular region. Moreover, under similar experimental conditions, the shrinkage level increases for increasing electric current density, up to a limit close to full shrinkage. Electrochemical impedance spectroscopy experiments were carried out in the ionic domain in flash sintered specimens. The Arrhenius plots of bulk and grain boundary contributions are evidence that for increasing electric current density the bulk conductivity is the same, but the grain boundary conductivity increases. It is proposed that the preferential paths for the electric current through the sample are the interfaces, mainly grain boundaries and pores. Moreover, the results give additional evidence for densification upon sintering without significant grain growth under electric field-assisted sintering.
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