Electrical behavior and microstructural features of conventionally and electric field-assisted sintered 3 mol% yttria-stabilized zirconia

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ZrO_2: 3 mol% Y_2O_3 ceramic powders, pressed to cylindrical pellets, were sintered conventionally at 1400°C (CS) and by applying an AC electric field in green (FS) and in pre-sintered (CS-FS) pellets. The electric field (200 $V.cm^{-1}$, 1 kHz frequency, 3 A limiting current) was applied at 1000°C. The experiments were carried out positioning cylindrical specimens inside a vertical dilatometer furnace, with platinum meshes at the parallel surfaces connected with platinum wires to a power supply. The density of CS, FS and CS-FS were 98.9, 98.6 and 99.1% of theoretical density respectively. The average grain size were 282±73, 340±108 and 387±138 nm for conventionally sintering, conventionally follow by flash sintering and only flash sintered samples. Although the samples have close density values, the bulk and grain boundary conductivities of samples submitted to electric field assisted sintering are higher than conventional sintered sample. The intragranular and intergranular conductivities obtained by electrochemical impedance spectroscopy of CS, FS and CS-FS samples were 8.7 and 9.8, 9.4 and 10.2 and 13.7 and 29.6 kΩ.cm, respectively. These results show that the application of an AC electric field to a green or pre-sintered solid electrolyte enhances its ionic conductivity due to the welding of the grains and the increased in the oxide ion concentration due to diffusion to the grains of the chemical species depleted at the space charge region, enhancing the oxide ion concentration, both phenomena are provoked by the Joule heating produced by the electric current flow.