DENSIFICATION AND GRAIN GROWTH KINETICS OF 3MOL% Y₂O₃ STABILIZED ZIRCONIA DURING FLASH SINTERING

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Flash sintering is an attractive technique that is capable of rapidly sintering ceramics, although its densification and microstructure evolution mechanism is arguable. Studies involving the kinetics of flash sintering are crucial in providing insights into the ultrafast densification process. Hence in the present study, a 3mol% Y₂O₃ stabilized zirconia (3YSZ) was used as a model compound for determining flash sintering densification and grain growth kinetics.

The densification kinetics of flash sintering was carried out at 900 °C, the dynamic linear shrinkage, the power dissipation and the evaluated temperature based on black-radiation model of 3YSZ sample was displayed as a function of electric field application time. Activation energy for the flash densification process was determined based on the conventional densification theory. Results indicated that injected oxygen vacancies at the incubation stage had a direct influence on the densification activation energy. In contrast, the densification during the flash sintering stage appeared to be dominated by the migration of oxygen vacancies under an electric field. This was inferred upon by the comparison of activation energies for the densification and conduction processes. Based on this finding, we propose that flash densification results from the movement of oxygen vacancies to form different charged defects that have an electrostatic interaction between them.

The grain growth kinetics on dense 3YSZ during steady stage of flash sintering was investigated using the grain size as a marker of microstructure evolution. In contrast to conventionally annealed specimen, the grain boundary mobility was enhanced by almost two orders of magnitude with the applied electric current, revealing that joule heating alone was not sufficient to account for the experimental results. Instead, activation energy for grain growth decreased significantly due to electro-sintering. Systematic characterization of graded microstructure further indicated that local oxygen vacancies and specimen temperature were responsible for a grain size transition. Based on electrochemical reaction involved in flash sintering, grain size reduction at the cathode was proposed to be attributed to the local rearrangement of lattice cations and generated oxygen ions.