ELECTRIC FIELD ASSISTED DENSIFICATION OF 10 MOL. % GADOLINIUM DOPED CERIA (GDC 10)

Tarini Prasad Mishra, Forschungszentrum Jülich GmbH
t.mishra@fz-juelich.de
Dr. Rubens Roberto Ingraci Neto, University of Colorado Boulder
PD Dr. Martin Bram, Forschungszentrum Jülich GmbH
Prof. Dr. Olivier Guillon, Forschungszentrum Jülich GmbH
Prof. Rishi Raj, University of Colorado Boulder

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Ceria based materials are widely studied due to their good chemical stability as compared to perovskites, mixed ionic and electronic conductivity and catalytic properties in redox processes. These unique properties make them attractive for applications in electro-chemical devices like electrolytes, diffusion barrier layers in solid oxide cells and/or oxygen ion conducting membranes. Gadolinium Doped Ceria (GDC) is one of the promising materials of this class of materials. However, GDC shows low densification behavior if sintered in air, requiring high temperature (i.e., 1400 – 1600 °C) and long dwelling time (2 – 6 hours) to densify. As an alternative to conventional sintering, flash sintering has been shown to be an effective method of sintering for many kinds of ceramics including mixed ionic and electronic conductors.

In this work, Ce0.9Gd0.1O1.95-δ (i.e. GDC10, gadolinium-doped ceria, with Gd 10 mol. %) has been used for conducting a related flash sintering study under the influence of electric field and current. Constant heating rate (voltage-to-current control) flash sintering experiments has been conducted for GDC 10 material to study the effect of electrical field on the onset behavior of flash. Results of this study hint on that Debye temperature is the lower bound temperature required for initiating the flash event. This experimental finding is supporting other similar findings for 8YSZ and 3YSZ materials.

An alternative way of flash sintering has been introduced for GDC 10 material. In conventional (voltage-to-current control) flash sintering experiment, a defined electric field is applied to the sample, and after the flash event the power supply switches from the voltage control to current control. In the alternative method, the current is controlled from the beginning of the experiment and increased at a defined rate. Using a constant current rate, the densification of the material can be better controlled than in conventional flash sintering and the microstructure can be tuned. To study the effect of current rate on the densification behavior of the GDC material, current controlled flash sintering at 8 different current rates was carried out. The experimental findings suggest that the final relative density of the sample depends on the current density rather than on the current rate. Moreover, the microstructure of the current rate flash sinter samples seems to be homogenous throughout the sample.

From different flash sintering experiments, a processing map for the GDC 10 material as a function of electrical field and current density is developed. The processing map is helpful in optimizing the sintering parameters by avoiding the failed zone.