Synthesis of Oxyapatite Ceramics for SOFC Electrolytes

S. Celerier[*♦], C. Laberty-Robert[*], F. Ansart[*], C. Calmet[*] and P. Stevens[+]

[*] CIRIMAT-LCMIE. Université Paul Sabatier, 118 route de Narbonne 31062 Toulouse Cedex 04, France
[+] ElFER, Karlsruhe, Allemagne ♦Corresponding author

Abstract

Solid oxide fuel cells have considerable interest in recent years, because of their high efficiency and environmentally friendly nature. Such systems required oxygen-conducting electrolytes and now the most common electrolyte is yttria stabilized zirconia (YSZ). This compound exhibits high oxide ion conductivity at elevated temperatures (850-1000°C). However, this high working temperature causes problems in terms of materials selection and lifetime. One solution is to develop new oxide ions conductors exhibiting high oxide ion conductivity at intermediary temperatures (700-800°C). Recent work has identified $Ln_{10-x}Si_6O_{26\pm z}$ (Ln = rare earths) as a good fast oxide ion conductor.

Undoped and doped $Ln_{10-x}B_6O_{26\pm z}$ (B = Si or Ge) oxides are currently prepared by solid-state methods. In that work, we propose a sol-gel process to synthesize powders of $La_{9.33}Si_6O_{26}$ type-silicated apatites. The main advantage is to decrease the crystallization temperature in comparison to the conventional methods, allowing the synthesis of reactive powders with nanometric particles size. These oxides are synthesized using silicon alkoxide and lanthanum nitride as precursors. In the litterature, no study refers to the synthesis of mixed oxides with silicon alcoxides. However, there are several studies on sol-gel synthesis of glasses with this precursor. In this study, several processing parameters have been investigated (the hydrolysis ratio, the concentration of metallic precursors in the sol and the role of organic compounds) in order to synthesize pure phases after the decomposition of the sols. Pure powders of $La_{9.33}Si_6O_{26}$ type-silicated apatites are obtained at 800°C.

These powders were used to prepare ceramics. Several processing parameters as morphology of powders (agglomeration, particle sizes) and, heating profiles have been studied on the densification. Dense ceramics (90-95%) have been prepared at temperatures around 1400°C. The used of sol-gel powders allow the decrease of the sintering temperature of about 200°C.