d. heating the green electrolyte at a rate of temperature increase whilst in the temperature range 800 - 1000°C of in the range 5 - 20°C/minute to form the electrolyte; wherein the anode layer has been applied to a metal substrate.

[0017] Often the process will comprise step a and one of steps b to d, often a combination of two or three or more of any of steps a to d or all of steps a to d to provide a dense, gas-tight doped ceria electrolyte. More specifically, it is possible to produce an electrolyte with a density of greater than 95% theoretical density, for instance in the range 95 - 100%, often 95.1, 97 or 98 - 100% density can be achieved. This reduces porosity and hence gas permeability, thus the electrolyte is gas-tight. Further, achieving an electrolyte density which is at such a high percentage of theoretical density ensures that the electrolyte has only very low levels of microscopic porosity, and hence is less prone to cracking (and hence failure) during use.

[0018] The doped-ceria green electrolyte will often be formed from a doped-ceria with high oxygen conductivity, such as a gadolinium doped-ceria (such as $Ce_{0.9}Gd_{0.1}O_{1.95}$ (CGO10)) or a samarium doped ceria (such as $Ce_{0.9}Sm_{0.1}O_{1.95}$). Often the doped-ceria green electrolyte will be formed from CGO (gadolinium doped-ceria). In many cases the doped-ceria will initially be in the form of a powder, such that an initial process step could be the provision of a doped-ceria powder. Often the powder will have a bimodal particle size distribution, with a peak at around 0.45 μm and a peak at around 1.6 μm.

[0019] The doped-ceria powder will often be of defined surface area, to ensure good sintering of the green electrolyte layer that will be formed. Often the doped-ceria powder will have a BET surface area in the range 15 - 40m²/g, more often 20 - 35m²/g, still more often 24 - 28 m²/g. It will generally be the case that, even where milling is used, the BET surface area of the powder will be in this range. The range of BET surface area of the powder is selected such that it is high enough to allow sufficient sinterability of the powder, but low enough to minimise the gaps which would appear between particles of too small a size (too high an individual surface area) ensuring that a density of the green electrolyte of at least 50% theoretical density can be obtained. Where green densities are in this range, it is easier to achieve final sintered electrolyte densities of greater than 95% theoretical density, ensuring the provision of an air tight, robust electrolyte. Using a doped-ceria powder with a BET surface area outside the specified range could result in either inadequate densification or cracking of the sintered layer.

Claims

1. A process for forming an electrolyte for a metal-supported solid-oxide fuel cell, the process comprising:

a. applying a doped-ceria green electrolyte to an anode layer;

b. removing any solvents and organic matter from the green electrolyte;

c. pressing the green electrolyte to increase green electrolyte density; and

d. heating the green electrolyte at a rate of temperature increase whilst in the temperature range 800°C - 1000°C of in the range 5 - 20°C/minute to form the electrolyte; wherein the anode layer has been applied to a metal substrate.

2. A process according to claim 1, comprising the additional step of forming the doped-ceria green electrolyte from a screen-printable ink.

3. A process according to claim 1 or claim 2, wherein the metal substrate comprises a perforated region surrounded by a non-perforated region.

4. A process according to any preceding claim, wherein the step of removing any solvents and organic matter from the green electrolyte comprises evaporating the solvents.

5. A process according to any preceding claim, wherein the step of removing any solvents and organic matter comprises heating the green electrolyte to a temperature in the range 250 - 500°C until the organic matter has decomposed.

6. A process according to any preceding claim, wherein the anode layer is a sintered anode layer.

7. A process according to any of claims 1 to 5, wherein the anode layer is a green anode layer and the green anode layer and green electrolyte are sintered in a single firing step.

8. A process according to any preceding claim, wherein the green electrolyte comprises multiple layers of electrolyte formed by applying the doped-ceria electrolyte in layers over the anode layer, with drying between the application of each layer.

9. A process according to any preceding claim, wherein pressing of the green electrolyte comprises application of a pressure in the range 50 - 500 MPa.

10. A process according to any preceding claim, wherein the electrolyte covers the anode layer and the metal substrate.

11. A process according to any preceding claim, wherein the step d. is performed in air.

12. A process according to any preceding claim, wherein the pressure is applied using cold isostatic pressing or uniaxial bladder pressing.

13. A process for forming a fuel cell comprising forming an electrolyte on a metal-supported anode layer using the process of any preceding claim, and applying a cathode material to the electrolyte.

14. An electrolyte obtained by the process according to any of claims 1 to 12.

15. A fuel cell comprising an electrolyte according to claim 14.

16. A fuel cell stack comprising at least two fuel cells according to claim 15.

17. Use of a fuel cell or fuel cell stack according to claim 15 or claim 16, respectively, in the generation of electrical energy.