BRIEF SUMMARY

[0013] According to a first aspect, there is provided a solid oxide fuel cell stack comprising at least one fuel cell strip, each strip comprising a plurality of bundles, each bundle comprising a plurality of tube sub-assemblies, each tube sub-assembly comprising a fuel cell tube, each fuel cell tube having at least one passage extending longitudinally through the fuel cell tube, adjacent tube sub-assemblies being arranged substantially parallel and spaced apart, at least one end of each tube sub-assembly being connected to an end of an adjacent tube sub-assembly via at least one end fitting, wherein the at least one end fitting comprises at least one channel.

[0014] A benefit of providing a plurality of channels within the end fitting is that the channel geometry may be adapted to control fuel flow through the plurality of channels and into the fuel cell tube. Surprisingly, it has been found that micro-control of the flow of fuel in a bottom up approach (i.e. from the fuel cell tube up to the fuel cell strip) may reduce thermal and mechanical stresses on the fragile fuel cell tubes and other components. Controlling the distribution of the flow of fuel throughout the fuel cell tube sub-assemblies may prevent fuel surges and pressure differences in fuel flow within the tube sub-assemblies.

[0015] Optionally, the at least one end fitting comprises a plurality of channels.

[0016] Optionally, the at least one end fitting comprises a fuel inlet or a fuel outlet.

[0017] Optionally, the at least one channel forms a gas tight conduit from the fuel inlet or the fuel outlet to the fuel cell tubes.

[0018] Optionally, the at least one channel has a length and wherein a cross sectional area of the at least one channel is a function of the length of the at least one channel.

[0019] Optionally, a coefficient of thermal expansion (CTE) of the at least one end fitting is matched to a CTE of the solid oxide fuel cell tubes.

[0020] Optionally, the at least one end fitting is made from impervious magnesia magnesium aluminate (MMA) ceramic material.

[0021] Optionally, one end of each tube sub-assembly comprises a first type end fitting, the opposing end of each tube sub-assembly comprises a second type end fitting, and wherein the first type end fitting of one tube sub-assembly and the second type end fitting of an adjacent tube sub-assembly are connected to provide a conduit between the fuel cell tubes of adjacent tube sub-assemblies.

[0022] Optionally, the first type end fitting has a first alignment feature compatible with a second alignment feature of the adjoining second type end fitting, providing alignment between adjacent first type end fitting and the second type end fitting.

[0038] Optionally, the location socket is cylindrical and is adapted to constrain latitudinal motion between adjacent tube sub-assemblies and to allow longitudinal motion between adjacent tube sub-assemblies.

[0039] Optionally, the location pin is cylindrical.

[0040] According to a second aspect, there is provided a solid oxide fuel cell stack comprising at least one fuel cell strip, each strip comprising a plurality of bundles, each bundle comprising a plurality of tube sub-assemblies, each tube sub-assembly comprising a fuel cell tube, each fuel cell tube having at least one passage extending longitudinally through the fuel cell tube, adjacent tube sub-assemblies being arranged substantially parallel and spaced apart, at least one end of each tube sub-assembly being connected to an end of an adjacent tube sub-assembly via at least one end fitting, an end of an uppermost tube sub-assembly and an end of a lowermost tube sub-assembly of each bundle each being provided with a fuel manifold end fitting, wherein the fuel manifold end fitting comprises at least one channel, the channel being configured for connecting the fuel cell tubes of the end of the uppermost tube sub-assembly to a first main strip fuel pipe and the end of the lowermost tube sub-assembly of each bundle to a second main strip fuel pipe.

[0041] Preferably, the fuel manifold end fitting comprises a plurality of channels. By providing a plurality of channels within the fuel manifold end fittings, the flow of fuel from a main fuel cell strip fuel pipe to the fuel cell tubes of the tube sub-assemblies including the flow of fuel to individual channels within the fuel cell tubes may be controlled. In addition the plurality of channels within the fuel manifold end fittings controls the flow of fuel to each of the individual fuel cell bundles within the fuel cell strip.

[0042] Optionally, wherein the at least one channel has a length and wherein a cross sectional area of the at least one channel is a function of the length of the at least one channel.

[0043] Optionally, the main strip fuel pipe is an inlet feed pipe.

[0044] Optionally, the main strip fuel pipe is an outlet feed pipe.

[0045] Optionally, a coefficient of thermal expansion (CTE) of the fuel manifold end fitting is matched to a CTE of the solid oxide fuel cell tubes.

[0046] Optionally, the fuel manifold end fitting is made from impervious magnesia magnesium aluminate (MMA) ceramic material.

[0047] Optionally, the inlet feed pipe and the outlet feed pipe are made from dense impervious ceramic material.

[0048] There is also disclosed a fuel manifold end fitting comprising at least one channel, the channel configured for connecting a fuel cell tube of an end of an uppermost tube sub-assembly of a bundle to a first main strip fuel pipe and an end of a lowermost tube sub-assembly of the bundle to a second main strip fuel pipe.

BRIEF DESCRIPTION OF THE DRAWINGS

[0049] Embodiments of the invention are further described hereinafter with reference to the accompanying drawings, in which:

Figure 1 shows a solid oxide fuel cell stack;

Figure 2 shows a fuel cell tube sub-assembly;

Figure 3 shows a section view of a fuel cell tube adjoining an end fitting forming a fuel flow channel through the end fitting a fuel cell tube sub-assembly of Figure 2;

Figure 4 shows a first end fitting;

Figure 5 shows a first end fitting;

Figure 6 shows a second end fitting;

Figure 7 shows a second end fitting;

Figure 8 shows views of first and the second end fittings;

Figure 9 shows a partial view of the tube sub-assembly;

Figure 10a shows a section view of a bonded joint of adjacent tube sub-assemblies using alternative end fittings as shown in figures 11 and 12;

Figure 10b shows a bonded joint of adjacent tube sub-assemblies using end fittings as shown in figure 8;

Figure 10c shows a section view of a bonded joint for adjacent tube sub-assemblies using end fittings as shown in figure 8;

Figure 10d shows a non-bonded joint for adjacent tube sub-assemblies using end fittings as shown in figure 8;

Figure 11 shows two views of an alternative first end fitting;

Figure 12 shows two views of an alternative end fitting;

Figure 13 shows a section view of a bundle;

Figure 14 shows a 3D perspective view of a bundle;