SUMMARY

[0005] In the present disclosure, set forth herein is a process for making a sintered bilayer, comprising: providing a green bilayer, comprising a green body layer and a metal layer, under tension of 1 N to 300 N per meter of web width; moving the green bilayer through a first heating zone to produce a debindered bilayer; moving the debindered bilayer through a second heating zone to prepare a sintered bilayer; wherein the debindered bilayer is in an arched configuration as the debindered bilayer moves through the second heating zone; wherein the debindered bilayer is in the second heating zone for about 1 second to about 3 minutes; wherein the temperature in the second heating zone is 1050 ˚C to 1250 ˚C; and wherein the thickness of the sintered bilayer is less than 100 μm.

[0005a] In one aspect, set forth is a process for making a sintered bilayer, comprising: providing a green bilayer, comprising a green body layer and a metal layer, wherein the green body layer comprises ceramic powder and a binder under tension of 1 N to 300 N per meter of web width; moving the green bilayer through a first heating zone to produce a debindered bilayer; moving the debindered bilayer through a second heating zone to prepare a sintered bilayer; wherein the debindered bilayer is in an arched configuration as the debindered bilayer moves through the second heating zone; wherein the debindered bilayer is in the second heating zone for about 1 second to about 3 minutes; wherein the tension is 10 N to 200 N per meter of web width in the second heating zone; wherein the temperature in the second heating zone is 1050 ˚C to 1250 ˚C; and wherein the thickness of the sintered bilayer is less than 100 μm.

[0006] In the present disclosure, set forth herein is a processing apparatus comprising: a front roller; at least one furnace comprising at least three heating zones; and a runway having a surface that comprises a material selected from: nickel (Ni), iron (Fe), a Ni-alloy, an Fe-alloy, a Ni-Fe alloy, stainless steel, pyrolytic carbon, carbon fiber composite (CFC), graphite, alumina (Al_2O_3), zirconia (ZrO_2), boron nitride, silicon carbide, magnesium oxide, or a combination thereof.

[0007] In the present disclosure, set forth herein is a processing apparatus comprising: a front roller; at least one furnace comprising at least three heating zones; and at least one of the following: baffles within a heating zone; baffles between two heating zones; curtain purges between two heating zones; means for controlling at least two

distinct pressure zones within the at least three heating zones; means for exhausting through the center of the at least one furnace; means for exhausting through the center of the runway; means for purging gas between two heating zones; means for isolating gas between two heating zones; means for mechanically separating two heating zones; or a combination thereof.

[0008] In the present disclosure, set forth herein is a processing apparatus comprising: a front roller; at least one furnace comprising at least three heating zones; and a bilayer held under tension, wherein the tension ranges from 0.1 g/cm to 500 g/cm of web width.

[0009] In the present disclosure, set forth herein is a processing apparatus comprising: a front roller; at least one furnace comprising at least three heating zones; a

bilayer; and at least two or more rollers; wherein the bilayer is wrapped around one of the at least two or more rollers at a wrap angle that ranges from 0 to 40 º.

[0010] In the present disclosure, set forth herein is a process of using a continuous process apparatus, comprising the following operations: (a) heating a green bilayer as the green bilayer moves through at least one furnace to produce a bilayer having less than 1 weight percentage (wt%) organic content, and (b) winding the bilayer having less than 1 wt% organic content onto a roller.

[0011] In the present disclosure, set forth herein is a process of using a continuous process apparatus, comprising the following operations: (a) providing, or having provided, a process apparatus as disclosed herein; (b) heating the bilayer as the bilayer moves through the at least one furnace to produce a bisqued bilayer, and (c) winding the bisqued body.

[0012] In the present disclosure, set forth herein is a process of using a continuous process apparatus, comprising the following operations: (a) providing, or having provided, a process apparatus as disclosed herein; (b) heating a bilayer as the bilayer moves through the at least one furnace to produce a sintered bilayer.

BRIEF DESCRIPTIONS OF THE DRAWINGS

[0013] **FIG. 1** shows one embodiment of a process apparatus having multiple heating and/or cooling zones and a series of internal rollers, which form the shape of a ramp in an arched configuration.

[0014] **FIG. 2** shows a portion of an embodiment of a process apparatus.

[0015] **FIG. 3** shows a series of tube furnaces in an embodiment of a process apparatus.

[0016] **FIG. 4** shows a series of tube furnaces in an embodiment of a process apparatus.

[0017] **FIG. 5** shows a picture of one embodiment of a process apparatus.

[0018] **FIG. 6** shows an image of a bilayer made in Example 8.

CLAIMS

What is claimed is:

1. A process for making a sintered bilayer, comprising:

providing a green bilayer, comprising a green body layer and a metal layer, wherein the green body layer comprises ceramic powder and a binder under tension of 1 N to 300 N per meter of web width;

moving the green bilayer through a first heating zone to produce a debindered bilayer;

moving the debindered bilayer through a second heating zone to prepare a sintered bilayer;

wherein the debindered bilayer is in an arched configuration as the debindered bilayer moves through the second heating zone;

wherein the debindered bilayer is in the second heating zone for about 1 second to about 3 minutes;

wherein the tension is 10 N to 200 N per meter of web width in the second heating zone;

wherein the temperature in the second heating zone is 1050 ˚C to 1250 ˚C; and

wherein the thickness of the sintered bilayer is less than 100 μm.

2. The process of claim 1, wherein the debindered bilayer is heated at a rate higher than 300 °C/min.
3. The process of claim 1 or 2, wherein the green bilayer is under the recited tension in the first heating zone.
4. The process of any one of claims 1-3, wherein the debindered bilayer is under the recited tension in the second heating zone.
5. The process of any one of claims 1-4, wherein the tension in the first heating zone is different than the tension in the second heating zone.
6. The process of any one of claims 1-5, wherein the tension in the first heating zone is lower than the tension in the second heating zone.
7. The process of any one of claims 1-6, wherein the tension is 3 N to 30 N per meter of web width in the first heating zone.
8. The process of any one of claims 1-7, wherein the tension is 40 N to 200 N per meter of web width in the second heating zone.
9. The process of any one of claims 1-8, wherein the tension is 40 N to 187.5 N per meter of web width in the second heating zone.

10. The process of any one of claims 1-9, wherein the tension is 31.1 N to 187.5 N per meter of web width in the second heating zone.
11. The process of any one of claims 1-10, wherein the tension is 125 N to 250 N per meter of web width in the first heating zone; and 10 N to 200 N per meter of web width in the second heating zone.
12. The process of any one of claims 1-11, wherein the sintered bilayer comprises sintered lithium-stuffed garnet.
13. The process of any one of claims 1-12, wherein the metal layer comprises nickel, iron, or an alloy thereof.
14. The process of any one of claims 1-13, wherein the sintered bilayer length is at least 1 meter.
15. The process of any one of claims 1-14, wherein the bilayer moves through the second heating zone at a rate from 1 cm/min to 200 cm/min.
16. The process of any one of claims 1-15, wherein debindered bilayer is in an arched configuration characterized by a radius of curvature of 0.5 meters to 6.0 meters.
17. The process of any one of claims 1-16, wherein at least one runway provides the arched configuration.
18. The process of any one of claims 1-17, wherein at least one roller provides the arched configuration.
19. The process of any one of claims 1-18, wherein at least one speed bump provides the arched configuration.
20. The process of any one of claims 1-19, wherein the debindered bilayer is in the second heating zone for about 10 seconds, 11 seconds, 12 seconds, 13 seconds, 14 seconds, 15 seconds, 16 seconds, 17 seconds, 18 seconds, 19 seconds, 20 seconds, 21 seconds, 22 seconds, 23 seconds, 24 seconds, 25 seconds, 26 seconds, 27 seconds, 28 seconds, 29 seconds, 30 seconds, 31 seconds, 32 seconds, 33 seconds, 34 seconds, 35 seconds, 36 seconds, 37 seconds, 38 seconds, 39 seconds, 40 seconds, 41 seconds, 42 seconds, 43 seconds, 44 seconds, 45 seconds, 46 seconds, 47 seconds, 48 seconds, 49 seconds, 50 seconds, 51 seconds, 52 seconds, 53 seconds, 54 seconds, 55 seconds, 56 seconds, 57 seconds, 58 seconds, 59 seconds, 60 seconds, 70 seconds, 80 seconds, or 90 seconds.