

What is Claimed is:

CLAIMS

1. A composite material for use as a radiofrequency component comprising:
5 a low temperature fireable outer material, the low temperature fireable outer material having a garnet or scheelite structure; and
a high dielectric inner material located within the outer material, the high dielectric inner material having a dielectric constant above 30, the low temperature fireable outer material and the high dielectric inner material being configured to be co-fired together at
10 temperature between 650-900 °C to form an integrated magnetic/dielectric assembly without the use of adhesive or glue.
2. The composite material of claim 1 wherein the low temperature fireable outer material includes BiVO₄.
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3. The composite material of claim 1 wherein the high dielectric inner material is shaped like a disc and the low temperature fireable outer material is shaped like a ring.
4. The composite material of claim 1 wherein the low temperature fireable outer material
20 includes a combination of BiVO₄ and Al₂O₃.
5. The composite material of claim 4 wherein the low temperature fireable outer material has a dielectric constant between 20 and 80.
- 25 6. The composite material of claim 4 wherein the Al₂O₃ is present in the low temperature fireable outer material an amount up to about 6 wt%.
7. The composite material of claim 4 wherein Bi₄V₂O₁₁ is present in the low temperature fireable outer material as a phase separate from the BiVO₄.
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8. The composite material of claim 4 wherein the low temperature fireable outer material further includes one or more of yttrium vanadate, gadolinium vanadate, or titanium oxide.

9. The composite material of claim 8 wherein the titanium oxide is present in the low temperature fireable outer material in an amount up to 10 wt%.
10. The composite material of claim 8 wherein one or both of yttrium vanadate,
5 gadolinium vanadate form a solid solution with the BiVO_4 in the low temperature fireable outer material.
11. The composite material of claim 8 wherein the titanium dioxide is present in the low temperature fireable outer material as a phase separate from the BiVO_4 .
- 10 12. The composite material of claim 8 wherein the gadolinium vanadate is present in the low temperature fireable outer material in an amount up to 50 wt%.
13. The composite material of claim 8 wherein $\text{Bi}_4\text{V}_2\text{O}_{11}$ and BiVO_4 are present in the
15 low temperature fireable outer material as separate phases.
14. The composite material of claim 13 wherein $\text{Bi}_4\text{V}_2\text{O}_{11}$, BiVO_4 , and $\text{Bi}_2\text{Ti}_4\text{O}_{11}$ are present in the low temperature fireable outer material as separate phases.
- 20 15. The composite material of claim 14 wherein $\text{Bi}_4\text{V}_2\text{O}_{11}$, BiVO_4 , $\text{Bi}_2\text{Ti}_4\text{O}_{11}$, and TiO_2 are present in the low temperature fireable outer material as separate phases.
16. The composite material of claim 8 wherein $\text{Bi}_4\text{V}_2\text{O}_{11}$ and GdVO_4 are present in the low temperature fireable outer material as separate phases.
- 25 17. A method of forming a composite material for use as an isolator or circulator in a radiofrequency device, the method comprising:
providing a low temperature fireable outer material, the low fireable outer material having a garnet or scheelite structure;
30 entering a high dielectric inner material within an aperture in the low temperature fireable outer material, the high dielectric inner material having a dielectric constant above 30; and
co-firing the lower temperature fireable outer material and the high dielectric inner material together at temperature between 650-900°C to shrink the low temperature fireable

outer material around an outer surface of the high dielectric inner material to form an integrated magnetic/dielectric assembly without the use of adhesive or glue.

18. The method of claim 17 wherein one of the low temperature fireable outer material
5 includes BiVO_4 , the low temperature fireable outer material includes a combination of BiVO_4
and Al_2O_3 , the Al_2O_3 is present in the low temperature fireable outer material an amount up
to about 6 wt%, $\text{Bi}_4\text{V}_2\text{O}_{11}$ is present in the low temperature fireable outer material as a phase
separate from the BiVO_4 , the low temperature fireable outer material further includes one or
10 more of yttrium vanadate, gadolinium vanadate, or titanium oxide, the titanium oxide is
present in the low temperature fireable outer material in an amount up to 10 wt%, one or both
of yttrium vanadate, gadolinium vanadate form a solid solution with the BiVO_4 in the low
temperature fireable outer material, the titanium dioxide is present in the low temperature
fireable outer material as a phase separate from the BiVO_4 , the gadolinium vanadate is
15 present in the low temperature fireable outer material in an amount up to 50 wt%, $\text{Bi}_4\text{V}_2\text{O}_{11}$
and BiVO_4 are present in the low temperature fireable outer material as separate phases,
 $\text{Bi}_4\text{V}_2\text{O}_{11}$, BiVO_4 , and $\text{Bi}_2\text{Ti}_4\text{O}_{11}$ are present in the low temperature fireable outer material as
separate phases, $\text{Bi}_4\text{V}_2\text{O}_{11}$, BiVO_4 , $\text{Bi}_2\text{Ti}_4\text{O}_{11}$, and TiO_2 are present in the low temperature
fireable outer material as separate phases, or $\text{Bi}_4\text{V}_2\text{O}_{11}$ and GdVO_4 are present in the low
temperature fireable outer material as separate phases.

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19. A radiofrequency isolator or circulator comprising:
a low temperature fireable outer material, the low temperature fireable outer material
having a garnet or scheelite structure; and
a high dielectric inner material located within the outer material, the high dielectric
25 inner material having a dielectric constant above 30, the low temperature fireable outer
material and the high dielectric inner material being configured to be co-fired together at
temperature between 650-900°C without the use of adhesive or glue.

20. The radiofrequency isolator or circulator of claim 19 wherein the low temperature
30 fireable outer material has a composition as recited in any of claims 2, 4, or 6-16.

21. The radiofrequency isolator or circulator of claim 19 included in an electronics device
module.

22. The radiofrequency isolator or circulator of claim 19 included in an RF electronics device.