CLAIMS

1. A heat spreader comprising:

a thermally conductive body configured to contact a heat source and a heat sink, in which at least a portion of the thermally conductive body or a coating thereon comprises a copper composite that comprises copper nanoparticles and a coefficient of thermal expansion (CTE) modifier.

2. The heat spreader of claim 1, wherein the copper composite is formed through consolidation of the copper nanoparticles with micron-size copper particles and the CTE modifier.

3. The heat spreader of claim 1, wherein the copper composite has a uniform nanoporosity of about 2% to about 30%.

4. The heat spreader of claim 1, wherein the CTE modifier comprises particles or fibers selected from the group consisting of carbon, W, Mo, diamond, boron nitride, aluminum nitride, silicon nitride, carbon nanotubes, graphene, graphite, copper oxide nanoparticles, and any combination thereof.

5. The heat spreader of claim 1, further comprising:

a plurality of thermally conductive fibers extending from at least a portion of the thermally conductive body or the coating thereon, if present.

6. The heat spreader of claim 1, wherein the thermally conductive body is wholly formed from the copper composite comprising the CTE modifier.

7. The heat spreader of claim 6, wherein the CTE modifier is distributed throughout the thermally conductive body.

8. The heat spreader of claim 1, wherein the thermally conductive body is tapered.

9. The heat spreader of claim 1, wherein the CTE modifier is present in the copper composite in a stepwise or gradient concentration distribution.

10. The heat spreader of claim 1, wherein the copper composite has a CTE of about 3 ppm to about 7 ppm.

11. A printed circuit board (PCB) comprising:

a heat-producing component located upon or recessed within an electrically insulating substrate; and

at least one heat spreader in thermal communication with the heat-

producing component, the at least one heat spreader comprising:

a thermally conductive body, in which at least a portion of the thermally conductive body or a coating thereon comprises a copper composite that comprises copper nanoparticles and a coefficient of thermal expansion (CTE) modifier.

12. The PCB of claim 11, wherein the copper composite is formed through consolidation of the copper nanoparticles with micron-size copper particles and the CTE modifier.
13. The PCB of claim 11, wherein the copper composite has a uniform nanoporosity of about 2% to about 30%.
14. The PCB of claim 11, wherein the at least one heat spreader is bonded to the heat-producing component via a bonding layer comprising a second copper composite that is CTE-matched to the heat-producing component.
15. The PCB of claim 14, wherein the second copper composite of the bonding layer has a uniform nanoporosity of about 2% to about 30%.
16. The PCB of claim 11, wherein the CTE modifier comprises particles or fibers selected from the group consisting of carbon, W, Mo, diamond, boron nitride, aluminum nitride, silicon nitride, carbon nanotubes, graphene, graphite, copper oxide nanoparticles, and any combination thereof.
17. The PCB of claim 11, wherein the thermally conductive body is wholly formed from the copper composite comprising the CTE modifier.
18. The PCB of claim 17, wherein the CTE modifier is distributed throughout the thermally conductive body.
19. The PCB of claim 11, wherein the thermally conductive body is tapered.
20. The PCB of claim 11, wherein the heat-producing component is located upon or recessed within a surface of the electrically insulating substrate, and:

the at least one heat spreader is bonded to a top surface of the heat-producing component,

the at least one heat spreader is bonded to a side surface of the heat-producing component,

the at least one heat spreader is bonded to a bottom surface of the heat-producing component and the at least one heat spreader extends through the electrically insulating substrate,

or any combination thereof.

21. The PCB of claim 11, wherein the CTE modifier is present in the copper composite in a stepwise or gradient concentration distribution.

22. The PCB of claim 11, wherein the copper composite has a CTE of about 3 ppm to about 7 ppm.

23. A heat dissipation system comprising:

a heat spreader having a thermally conductive body, in which at least a portion of the thermally conductive body or a coating thereon comprises a copper composite that comprises a coefficient of thermal expansion (CTE) modifier, such that the thermally conductive body has a CTE of about 3 ppm to about 7 ppm;

a heat-producing component in contact with a first surface of the thermally conductive body, the heat-producing component having a CTE of about 3 ppm to about 7 ppm; and

a heat sink or a heat pipe in contact with a second surface of the thermally conductive body;

wherein the heat sink or the heat pipe is also formed from the copper composite comprising the coefficient of thermal expansion modifier and has a CTE of about 3 to about 7 ppm.

24. The heat dissipation system of claim 23, wherein the thermally conductive body or the coating thereon is metallurgically bonded to the heat sink or the heat pipe via a bonding layer.

25. The heat dissipation system of claim 23, wherein the thermally conductive body or the coating thereon has a CTE within about ±20% of the heat-producing component.