Claims

1. A thermal control system comprising an inorganic phase change material and an organic phase change material.

2. The thermal control system according to claim 1, wherein the inorganic phase change material and the organic phase change material are physically mixed with each other, or wherein the inorganic phase change material forms a first layer and the organic phase change material forms a second layer, whereby the first layer and the second layer are physically distinct from each other.

3. The thermal control system according to claim 1 or 2, wherein the organic phase change material and the inorganic phase change material are present at a ratio in the range of 1:1 to 1:5 by weight or wherein the organic phase change material and the inorganic phase change material is independently present at a thickness in the range of 5 mm to 3 cm.

4. The thermal control system according to claim 2 or 3, wherein the first layer and the second layer are separated by a layer of fluid or are in direct contact with each other, or wherein the first layer is the inner layer and the second layer is the outer layer, or the first layer is the outer layer and the second layer is the inner layer, relative to an item to be cooled, wherein the inner layer at least partially surrounds the item to be cooled, and the outer layer at least partially surrounds the inner layer, and wherein the outer layer and inner layer are of the same temperature, or wherein the outer layer is of a relatively lower temperature than the inner layer.

5. The thermal control system according to any one of the preceding claims, wherein the inorganic phase change material comprises a salt and a first additive, wherein the salt comprises a first metal selected from group 1, group 2, group 7, group 8, group 9, group 10, group 12 or group 13 of the Periodic Table of Elements, and an anion, and wherein the first additive is a nano-sized material, a micro-sized material or a mixture thereof, or wherein the thermal conductivity of the first additive is in the range of about 0.005 W/(m*K) to about 0.07 W/(m*K).

6. The thermal control system according to claim 5, wherein the inorganic phase change material comprises 5 wt% to 35 wt% salt.

7. The thermal control system according to claim 5 or 6, wherein the inorganic phase change material comprises:

about 70 wt% to about 80 wt% water;

about 15 wt% to about 25 wt% $CaCl_2.6H_2O$

about 3 wt% to about 4 wt% NaCl;

about 0.2 wt% to about 0.7 wt% porous silica microstructure; and

about 0.5 wt% to about 1.5 wt% carbon fiber nanostructure,

such that the total wt% of each component adds to 100 wt%.

8. The thermal control system according to any one of the preceding claims, wherein the organic phase change material comprises a hydrocarbon and a second additive, wherein the hydrocarbon is an optionally functionalized aliphatic and wherein the second additive is a nano-sized material, a micro-sized material or a mixture thereof, or wherein the thermal conductivity of the second additive is in the range of about 20-50 W/(m*K).

9. The thermal control system according to claim 8, wherein the organic phase change material comprises about 50 wt% to about 98 wt% hydrocarbon.

10. The thermal control system according to claim 8 or 9, wherein the organic phase change material comprises:

about 65 wt% to about 75 wt% $C_{11}H_{24}$ hydrocarbon;

about 15 wt% to about 25 wt% $C_{12}H_{26}$ hydrocarbon;

about 2.5 wt% to about 7.5 wt% $C_{13}H_{28}$ hydrocarbon;

about 1.5 wt% to about 2.5 wt% carbon nanotube; and **[**

about 2.5 wt% to about 3.5 wt% copper nanoparticle,

such that the total wt% of each component adds to 100 wt%.

11. The thermal control system according to any one of claims 8 to 10, wherein the organic phase change material comprises:

about 5 wt% to about 15 wt% hydrocarbon selected from the group consisting of $C_{10}H_{22}$, $C_{11}H_{24}$ and $C_{14}H_{30}$;

about 25 wt% to about 35 wt% $C_{12}H_{26}$ hydrocarbon;

about 55 wt% to about 65 wt% $C_{13}H_{28}$ hydrocarbon; and

about 0.5 wt% to about 2 wt% carbon nanostructure;

such that the total wt% of each component adds to 100 wt%.

12. The thermal control system according to any one of the preceding claims comprising:

about 35 wt% to about 40 wt% water;

about 7.5 wt% to about 12.5 wt% $CaCl_2.6H_2O$

about 1.5 wt% to about 2 wt% NaCl;

about 0.1 wt% to about 0.35 wt% porous silica microstructure;

about 0.25 wt% to about 0.75 wt% carbon fiber nanostructure,

about 32.5 wt% to about 37.5 wt% $C_{11}H_{24}$ hydrocarbon;

about 7.5 wt% to about 12.5 wt% $C_{12}H_{26}$ hydrocarbon;

about 1.25 wt% to about 3.75 wt% $C_{13}H_{28}$ hydrocarbon;

about 0.75 wt% to about 1.25 wt% carbon nanotube; and

about 1.25 wt% to about 1.75 wt% copper nanoparticle,

such that the total wt% of each component adds to 100 wt%.

13. The thermal control system according to any one of claims 1 to 11 comprising::

about 35 wt% to about 40 wt% water;

about 7.5 wt% to about 12.5 wt% $CaCl_2.6H_2O$

about 1.5 wt% to about 2 wt% NaCl;

about 0.1 wt% to about 0.35 wt% porous silica microstructure;

about 0.25 wt% to about 0.75 wt% carbon fiber nanostructure,

about 2.5 wt% to about 7.5 wt% hydrocarbon selected from the group consisting of $C_{10}H_{22}$, $C_{11}H_{24}$ and $C_{14}H_{30}$;

about 12.5 wt% to about 17.5 wt% $C_{12}H_{26}$ hydrocarbon;

about 27.5 wt% to about 32.5 wt% $C_{13}H_{28}$ hydrocarbon; and

about 0.25 wt% to about 1 wt% carbon nanostructure;

such that the total wt% of each component adds to 100 wt%.

14. The thermal control system according to any one of the preceding claims, further comprising a thermally insulating material at least partially surrounding the inorganic phase change material and the organic phase change material.

15. The thermal control system according to claim 14, comprising an inner thermally insulating material which at least partially surrounds the inorganic and organic phase change material, and an outer thermally insulating material which at least partially surrounds the inner phase change material.

16. A method of preparing a thermal control system, the method comprising the step of

contacting an inorganic phase change material with an organic phase change material.

17. The method according to claim 16, wherein the contacting step results in direct contact between the inorganic phase change material and the organic phase change material, or wherein the contacting step comprises the step of bringing the inorganic phase change material and the organic phase change material together with a layer of fluid in between.

18. The method according to claim 16 or 17, further comprising the step of at least partially surrounding an item to be cooled with the inorganic phase change material and the organic phase change material, or further comprising the step of at least partially surrounding the inorganic phase change material and the organic phase change material with a thermally insulating material.

19. A method for maintaining a temperature of an item, the method comprising the step of providing a thermal control system comprising an inorganic phase change material and an organic phase change material.

20. The method according to claim 19, further comprising the steps of pre-cooling the organic phase change material and/or the inorganic phase change material to a temperature below -15 °C, and contacting or at least partially surrounding an item to be cooled with the thermal control system.