## CLAIMS

We claim:

1. A method for preventing or delaying the onset of a phase change on a surface, said method comprising:

providing a modified surface that comprises a surface modification, wherein the modified surface increases the energy barrier to a phase change or driving force required for a phase change from a first phase to a second phase for a substance that is in contact with the modified surface, in comparison to an unmodified surface that is identical to the modified surface with the exception that the unmodified surface does not comprise the surface modification; and

contacting a fluid stream that comprises a substance in at least one first phase comprising the substance in a vapor phase and/or in a liquid phase with said modified surface under environmental conditions at which phase change to a second phase would occur on the unmodified surface,

wherein said phase change is prevented or delayed on said modified surface in comparison to the unmodified surface,

wherein said at least one first phase comprises a vapor phase, wherein said second phase comprises a solid phase, and wherein said prevention or delay of phase change comprises prevention or delay of solidification of said vapor to form a solid on said surface,

wherein said vapor is $CO_2$ gas, said solid is frozen $CO_2$, and the prevention or delay of phase change comprises prevention or delay of solidification of said $CO_2$ gas to form frozen $CO_2$ on the surface.

~~2. The method of claim 1, wherein said at least one first phase comprises a vapor phase comprising water vapor, wherein said second phase comprises a liquid phase comprising water, and wherein said prevention or delay of phase change comprises prevention or delay of condensation of said vapor to form a liquid on said surface.~~

3. The method of claim 1, wherein said at least one first phase comprises a vapor phase comprising water, wherein said second phase comprises a solid phase comprising water, wherein said vapor condenses on said surface to form a condensate, and wherein said prevention or delay of phase change comprises prevention or delay of solidification of said condensate to form a solid on said surface.

4. The method of claim 1, wherein said at least one first phase comprises a vapor phase comprising water and a liquid phase, wherein said second phase comprises a liquid phase comprising water, and wherein said prevention or delay of phase change comprises prevention or delay of condensation of said vapor to form a liquid on said surface.

5. The method of claim 1, wherein said at least one first phase comprises a vapor phase comprising water and a liquid phase, wherein said second phase comprises a solid phase comprising water, wherein said surface comprises condensate from said vapor and/or liquid, and wherein said prevention or delay of phase change comprises prevention or delay of solidification of said condensate and/or said liquid to form a solid on said surface.

6. The method of claim 1, wherein said at least one first phase comprises a vapor phase, wherein said second phase comprises a solid phase, and wherein said prevention or delay of phase change comprises prevention or delay of solidification of said vapor to form a solid on said surface.

7. The method of claim 6, wherein said vapor is water vapor, said solid is water frost or ice, and wherein said prevention or delay of phase change comprises prevention or delay of solidification of said water vapor to form water frost or ice on said surface.

~~8. The method of claim 6, wherein said vapor is $CO_2$ gas, said solid is frozen $CO_2$, and the prevention or delay of phase change comprises prevention or delay of solidification of said $CO_2$ gas to form frozen $CO_2$ on the surface.~~

~~9. The method of claim 1, wherein said modified surface is subcooled below the equilibrium phase transition value of said first phase to said second phase and said substance still exists in the first phase.~~

~~10. The method of claim 9, wherein said modified surface is subcooled by greater than about 0.25 °C below the equilibrium phase transition value of said first phase to said second phase and said substance still exists in the first phase.~~

~~11.~~2. The method of claim 1, wherein the energy barrier to phase change from said first phase to said second phase is greater than about 50% of the homogenous nucleation energy.

3. The method of claim 1, wherein the energy barrier to phase change from said first phase to said second phase on said modified surface is greater than about 60% of the homogenous nucleation energy.

4. The method of claim 3, wherein the energy barrier to phase change from said first phase to said second phase on said modified surface is greater than about 70% of the homogenous nucleation energy.

5. The method of claim 4, wherein the energy barrier to phase change from said first phase to said second phase on said modified surface is greater than about 80% of the homogenous nucleation energy.

6. The method of claim 5, wherein the energy barrier to phase change from said first phase to said second phase on said modified surface is greater than about 90% of the homogenous nucleation energy.

7. The method of claim 6, wherein the energy barrier to phase change from said first phase to said second phase on said modified surface is greater than about 95% of the homogenous nucleation energy.

8. The method of claim 7, wherein the energy barrier to phase change from said first phase to said second phase on said modified surface is greater than about 99% of the homogenous nucleation energy.

~~12. The method of any preceding claim, wherein said phase change from said first phase to said second phase comprises nucleation of said substance on said surface modification, and wherein the surface modification comprises a barrier coating, a conversion coating, or a combination thereof.~~

~~13. The method of claim 12, wherein the surface modification where nucleation occurs is nanostructured.~~

~~14. The method of claim 12 or 13, wherein the surface modification where nucleation occurs comprises a metal oxide or a polymer.~~

~~15. The method of claim 14, wherein the surface modification where nucleation occurs comprises one or more terminal alkyl or fluorinated compound(s).~~

~~16. A heat exchanger or heat transfer surface comprising a modified surface that comprises a surface modification, wherein the modified surface increases the energy barrier to or driving force required for a phase change from a first phase to a second phase for a substance that is in contact with the modified surface, in comparison to an unmodified surface that is identical to the modified surface with the exception that the unmodified surface does not comprise the surface modification, wherein the onset of said phase change is prevented or delayed in said heat exchanger or heat transfer surface in comparison to a heat exchanger or heat transfer surface that does not comprise the modified surface.~~

~~17. A glass, window, mirror, or lens comprising a modified surface that comprises a surface modification, wherein the modified surface increases the energy barrier to or driving force required for a phase change from a first phase to a second phase for a substance that is in contact with the modified surface, in comparison to an unmodified surface that is identical to the modified surface with the exception that the unmodified surface does not comprise the surface modification, wherein the onset of said phase change is prevented or delayed on said glass, window, mirror, or lens, in comparison to a glass, window, mirror, or lens that does not comprise the modified surface.~~

~~18.~~9. A computer case or cooling rack comprising a modified surface that comprises a surface modification, wherein the modified surface increases the energy barrier to or driving force required for a phase change from a first phase to a second phase for a substance that is in contact with the modified surface, in comparison to an unmodified surface that is identical to the modified surface with the exception that the unmodified surface does not comprise the surface modification, wherein the onset of said phase change is prevented or delayed on said computer case or cooling rack, in comparison to a computer case or cooling rack that does not comprise the modified surface, wherein said phase change comprises condensation of water, and wherein said modified surface prevents or reduces condensation related damage to electronics housed therein in comparison to an unmodified surface.

~~19. A gas vaporizer or gas vaporizer heat exchanger comprising a modified surface that comprises a surface modification, wherein the modified surface increases the energy barrier to or driving force required for a phase change from a first phase to a second phase for a substance, in comparison to an unmodified surface that is identical to the modified surface with the exception that the unmodified surface does not comprise the surface modification, wherein the onset of said phase change is prevented or delayed on said gas vaporizer, wherein said substance is water and said phase change~~

~~comprise condensation of water and/or formation of frost, and wherein said modified surface prevents or reduces condensation and/or frost formation in said gas vaporizer or gas vaporizer heat exchanger in comparison to an unmodified surface.~~

~~20.~~10. The method of claim 1, wherein the modified surface is on metal vapor lighting or advanced lithography equipment, wherein the substance is a metal, and wherein the phase change comprises metal vapor condensation, and wherein the modified surface prevents or reduces metal vapor condensation during operation of said metal vapor lighting or advanced lithography equipment.

11. The method of claim 10, wherein uniformity and prevention of deposition is critical to precise operation of said advanced lithography equipment

12. The method of claim 1, wherein the modified surface is in an engine or combustion nozzle, wherein said substance is carbon dioxide, wherein the phase change comprises condensation of carbon dioxide, and wherein the modified surface prevents or reduces carbon dioxide condensation in the engine or combustion nozzle in comparison to an unmodified surface.

13. The method of claim 1, wherein the modified surface is on processing equipment for industrial gases and/or liquids, wherein the substance is raw natural gas, wherein the phase change comprises hydration or host-guest complexing, and wherein the modified surface prevents or reduces water and gas hydrate and/or clathrate formation during the processing of said industrial gases and liquids in said process equipment in comparison to an unmodified surface.

14. The method of claim 13, wherein said first phase is a vapor or liquid, and said second phase is a supercritical phase

15. A glass component comprising a patterned modified surface that comprises a surface modification, wherein the modified surface increases the energy barrier to or driving

force required for a phase change from a first phase to a second phase for a substance that is in contact with the modified surface, in comparison to an unmodified surface that is identical to the modified surface with the exception that the unmodified surface does not comprise the surface modification, wherein the onset of said phase change is prevented or delayed on said modified surface in comparison to the unmodified surface, and wherein said modified surface is configured in a decorative pattern on said glass such that said phase change occurs in an aesthetically pleasing manner.

16. The method of claim 1, wherein the modified surface is in a pattern on a glass component such that said phase change occurs in an aesthetically pleasing manner.

17. The method of claim 1, wherein said substance is carbon dioxide, and wherein said first phase comprises carbon dioxide vapor and said second phase is dry ice.

18. The method of claim 1, wherein said substance is raw natural gas, and wherein said first phase comprises gas vapor and said second phase comprises a clathrate.

19. The method of claim 1 or claim 38, wherein said first phase is a vapor or liquid, and said second phase is a supercritical phase.

20. The method of claim 1, wherein said substance is a metal, and wherein said first phase comprises metal vapor and said second phase comprises condensed metal vapor.

21. The method of claim 1, wherein the modified surface is on a computer case or cooling rack.