## CLAIMS

1. A phase change memory (PCM) structure configured for performing a gradual reset operation, the PCM structure comprising:

first and second electrodes;

a phase change material layer disposed between the first and second electrodes; and

a thermal insulation layer disposed on at least sidewalls of the first and second electrodes and phase change material layer, the thermal insulation layer being configured to provide non-uniform heating of the phase change material layer.; and

2. The PCM structure of claim 1, wherein the phase change material layer and the first and second electrodes each have a discoid form factor, the phase change material layer being disposed on an upper surface of the first electrode and the second electrode being disposed on an upper surface of the phase change material layer, and wherein the thermal insulation layer is disposed concentrically surrounding the first and second electrodes and phase change material layer.

3. The PCM structure of claim 2, wherein the thermal insulation layer is substantially planar with outer surfaces of the first and second electrodes.

4. The PCM structure of claim 1, wherein at least one of the first and second electrodes comprises a material having a thermal conductance of less than about 100 watts per meter-kelvin.

5. The PCM structure of claim 1, wherein the thermal insulation layer comprises a material having a thermal conductivity of less than about 0.1 watts per meter-kelvin.

6. The PCM structure of claim 1, wherein the PCM structure has a discoid form factor, and wherein a ratio of a width of the PCM structure, along a major axis of the first electrode, to a height of the PCM structure, along an axis perpendicular to the major axis of the first electrode, is at least 20:1.

7. The PCM structure of claim 1, further comprising a substrate, wherein the first and second electrodes are disposed on an upper surface of the substrate and spaced laterally from one another, the phase change material layer is disposed on the upper surface of the substrate between the first and second electrodes and on an upper surface of the first and second electrodes, and the thermal insulation layer is disposed on a portion of the upper surface of the substrate and on an upper surface of

the phase change material layer to thereby encapsulate the first and second electrodes and phase change material layer.

~~8~~2. The PCM structure of claim 1, wherein at least one of the first and second electrodes comprises a material having a thermal conductance of less than about 100 watts per meter-kelvin.

3. The PCM structure of claim 1, wherein the thermal insulation layer comprises a material having a thermal conductivity of less than about 0.1 watts per meter-kelvin.

~~7~~4. The PCM structure of claim 1, wherein the PCM structure has a substantially rectangular form factor.

~~9~~5. The PCM structure of claim ~~7~~1, further comprising a channel formed in the upper surface of the phase change material layer between the first and second electrodes.

~~10~~6. The PCM structure of claim ~~1~~5, wherein ~~a width of~~ the ~~PCM structure along a major axis is about 100 nanometers (nm) to about 1 micron (μm), and a height~~ upper surface of the ~~PCM structure along an axis perpendicular to the major axis is about 5 nm to about 50 nm~~phase change material layer has a stepped profile.

~~11.~~7. The PCM structure of claim 1, wherein the PCM structure is configured to have a length in a range from about 5 nm to about 50 nm, and have a width in a range from about 100 nm to about 1 μm, wherein a ratio of width-to-length of the PCM structure is about 20:1.

8. The PCM structure of claim 1, wherein a thickness of a combined thermal insulation layer and substrate is in a range from about 30 nm to about 300 nm.

9. The PCM structure of claim 1, wherein a cross-sectional thickness of the phase change material layer is in a range from about 20 nm to about 200 nm.

10. The PCM structure of claim 1, wherein a thickness of the phase change material layer os selected based at least in part on at least one of resistance and power switching requirments of the PCM structure.

11. The PCM structure of claim 1, wherein the first and second electrodes are laterally separated and are substantially in a same plane relative to one another.

12. The PCM structure of claim 1, responsive to a bias signal being applied between the first and second electrodes, an induced current flows laterally through the phase change material layer.

13. The PCM structure of claim 1, wherein the substrate comprises a material having a thermal conductivity ~~that is~~of less than about 0.1 watts per meter-kelvin ~~(W/m·K)~~.

14. ~~12.~~ The PCM structure of claim 1, ~~further comprising a dielectric cap~~wherein the substrate and the thermal insulation layer are formed ~~over an upper surface and sidewalls~~ of a same material.

15. ~~the~~The PCM structure of claim 1, wherein the substrate and the thermal insulation layer are formed of different materials.

16. The PCM structure of claim 1, wherein the thermal insulation layer is formed as an air gap ~~between the dielectric cap layer and the phase change material layer~~.

17. The ~~13. A method of forming a phase change memory (~~PCM~~)~~ structure ~~configured for performing a gradual reset operation, the method comprising:~~

~~forming first and second electrodes;~~

~~forming a phase change material layer between the first and second electrodes; and~~

~~forming a thermal insulation layer on at least sidewalls of the first and second electrodes and phase change material layer, the thermal insulation layer being configured to provide non-uniform heating of the phase change material layer.~~

~~14. The method~~ of claim ~~13, further comprising:~~

~~forming a dielectric cap layer on at least an upper surface and sidewalls of the thermal insulation layer; and~~

~~performing a selective etch to remove the thermal insulation layer and thereby form an air gap providing a thermal insulation function to allow non-uniform heating of the phase change material layer~~1.

15. The method of claim 13, wherein forming the first and second electrodes and phase change material layer comprises:

forming a dielectric substrate;

depositing the first and second electrodes on an upper surface of the dielectric substrate, the first and second electrodes being spaced laterally from one another, the first and second electrodes being substantially planar with one another; and

depositing the phase change material layer on an upper surface of the first and second electrodes and on the upper surface of the dielectric substrate between the first and second electrodes.

16. The method of claim 15, further comprising forming a channel in an upper surface of the phase change material layer between the first and second electrodes.

17. The method of claim 13, wherein forming the first and second electrodes and phase change material layer comprises:

depositing the phase change material layer on an upper surface of the first electrode; and

depositing the second electrode on an upper surface of the phase change material layer;

wherein the first and second electrodes and phase change material layer are aligned with one another in a substantially vertical arrangement.

18. The method of claim 13, wherein the thermal insulation layer comprises a material having a thermal conductivity of less than about 0.1 watts per meter-kelvin.

19. The method of claim 13, further comprising forming the PCM structure to have a discoid form factor, the phase change material layer being disposed on an upper surface of the first electrode and the second electrode being disposed on an upper surface of the phase change material layer, and wherein the thermal insulation layer is disposed concentrically surrounding the first and second electrodes and phase change material layer.

20. A method of performing a gradual reset operation in a phase change memory (PCM) structure, the PCM structure including first and second electrodes, a phase change material layer disposed between the first and second electrodes, and a thermal insulation layer disposed on at least sidewalls of the first and second electrodes and phase change material layer, the method comprising:

applying a first reset pulse between the first and second electrodes, the first reset pulse having an amplitude that is greater than a crystalline phase change material switching threshold voltage and less than an amphorous phase change material switching threshold voltage, for a prescribed duration to causecauses a temperature of the phase change material layer to rise until a temperature in a center portion of the phase change material layer exceeds a phase change material melting temperature, resulting inwherein the center portion of the phase change material layer switchingswitches to a high-resistance amorphous state; and

, wherein applying at least one subsequent reset pulse between the first and second electrodes, the at least one subsequent reset pulse having an amplitude and duration that is the same as the first reset pulse, causingcauses a temperature of the phase change material layer to rise until a temperature in a portion of the phase change material layer adjacent to the center portion exceeds a phase change material melting temperature, resulting inwherein the portion of the phase change material layer adjacent to the center portion switchingswitches to a high-resistance amorphous state while the center portion of the phase change maeria layer remains in the high-resistance amorphous state.