regions, S1-S7. FIGS. 31E and 31F show detailed views of sub-regions S1-S7. Attributes of the various sub-regions are as follows.

[0170] S1, S2 and S3 are temperature sensors (S2 and S3 have similar design to one another); S4 & S5 are heaters, carry high currents during operation and have similar design to one another; S6 & S7 are heaters, carry high currents during operation and have similar design to one another. Since all the sensors and heaters are operated at the same time, there should be no shorting between metals of these sensors/heaters.

[0171] For S1, S2, and S3, the nominal width of metal in the heater elements is ~20 μm, and the nominal gap between adjacent portions of metal is ~10 μm. It has been found that sensor lines should optimally sense in at least 95% of the defined sensing area. The resistance of the sensors has to be within a defined range: lower values cause loss of sensitivity, resistors higher than certain values are not able to be read by some control circuitry. Pits no larger than half the width of the sensor line should be present on the oxide surface (10 μm). As the surface of the heater is mechanically pressed against by for example, a plastic microfluidic cartridge repeatedly, pits cause the metal to wear out over time.

[0172] For S4, and S5, the nominal width of metal in the heater elements is ~60 μm, and the nominal gap between adjacent portions of metal is ~60 μm. For this region, the heaters should cover almost 100% of the heating area to provide pre-defined heating pattern. Since heaters carry high currents, pits will cause hot spots in the heater and will cause the heater to fail over repeated operation. Pits no larger than half the width of the heater line should be present on the oxide surface. As the surface of the heater is mechanically pressed against by for example, a plastic microfluidic cartridge repeatedly, pits cause the metal to wear out over time. The resistance of heater should be within a controlled range in order to carry desired current.

[0173] For S6, S7: the nominal width of metal in the heater elements is ~45 μm; the nominal gap is ~45 μm. The heater should cover almost 100% of the heating area to provide pre-defined heating pattern. Since heaters carry high currents, pits will cause hot spots in the heater and will cause the heater to fail over repeated operation. Pits no larger than half the width of the heater line (~25 μm) should be present on the oxide surface. As the surface of the heater is mechanically pressed against by for example, a plastic microfluidic cartridge repeatedly, pits cause the metal to wear out over time. The resistance of heater should be within a controlled range in order to carry desired current.

[0174] For region B, the nominal width of metal in the heater elements is ~75 μm, and the nominal gap is ~125 μm. These sensors are also used as a heater and carry high currents during operation. The heater should cover almost 100% of the heating area to provide pre-defined heating pattern. The resistance of the sensors has to be within a defined range: lower values cause loss of sensitivity, resistors higher than certain values are not able to be read by some control circuitry. Pits no larger than half the width of the heater line (~40 μm) should be present on the oxide surface. Since heaters carry high currents, pits in the metal will cause hot spots in the heater and will cause the heater to fail over repeated operation. As the surface of the heater is mechanically pressed against by for example, a plastic microfluidic cartridge repeatedly, pits cause the metal to wear out over time. The resistance of heater should be within a controlled range in order to carry desired current.

[0175] The foregoing description is intended to illustrate various aspects of the present technology. It is not intended that the examples presented herein limit the scope of the present technology. The technology now being fully described, it will be apparent to one of ordinary skill in the art that many changes and modifications can be made thereto without departing from the spirit or scope of the appended claims.

What is claimed:

1. A heater unit, comprising:

a substrate having embedded therein a plurality of groups of resistive heaters, and at least one temperature sensor per group of heaters; and

control circuitry for supplying electric current to the plurality of groups of resistive heaters at selected intervals, wherein

the substrate has a surface configured to make thermal contact with a microfluidic cartridge having a plurality of PCR reaction chambers, and to deliver heat from the plurality of groups of resistive heaters to regions of the cartridge, such that each of the groups of resistive heaters delivers heat to a select PCR reaction chamber to perform a reaction, wherein the heat delivery from each group of resistive heaters is controlled by sensing temperature using the at least one temperature sensor of the group.

2. The heater unit of claim **1**, wherein a group of resistive heaters is shaped similar to a reaction chamber and the resistive heaters in the group are arranged to provide uniform heating in an area enclosed by the group.

3. The heater unit of claim **2**, wherein the area is between 1 mm^2 and 100 mm^2.

4. The heater unit of claim **1**, wherein a group consists of two long heaters and two short heaters.

5. The heater unit of claim **4**, wherein the two long heaters and the two short heaters are connected in series or parallel.

6. The heater unit of claim **1**, wherein at least one of the resistive heaters in a group of resistive heaters is also a temperature sensor.

7. The heater unit of claim **1**, wherein two adjacent heater groups are spaced apart by a distance to permit independent operation of their respective adjacent reaction chambers in the microfluidic cartridge.

8. The heater unit of claim **1**, wherein the reaction performed is thermocycling for PCR.

9. The heater unit of claim **8**, wherein one PCR heat cycle is performed in less than about 25 seconds.

10. The heater unit of claim **1**, wherein a portion of the substrate is removed from around the resistive heaters to reduce the effective thermal mass of the heater group.

11. The heater unit of claim **10**, wherein the PCR heat cycle time is further reduced by forced cooling during the cooling part of the PCR cycle.

12. The heater unit of claim **1**, further comprising heaters to actuate other microfluidic components in the microfluidic cartridge, including valves, pumps, or gates.

13. The heater unit of claim **1**, further comprising a processor, wherein the processor is programmable to operate the control circuitry.

14. The heater unit of claim **1**, further comprising a compliant layer at the surface, configured to thermally couple the