CLAIMS

1. A method for converting heat energy to electric power using sub-micron gap thermo photovoltaic technology, comprising the steps of:

collecting heat energy by a collecting surface of a radiation-emitting layer from an inner surface of a thermally-conductive shell, an outer surface of the thermally-conductive shell being exposed to a heat energy source;

maintaining a receiving surface of a photovoltaic cell by spacers in a micro gap less than one micron distance from an emitting surface of the radiation-emitting layer;

receiving electromagnetic radiation by the receiving surface from the emitting surface;

providing pressure on the photovoltaic cell by a thermally conductive, deformable foil membrane forming a wall of a pressurized chamber containing liquid metal for keeping the collecting surface of the radiation-emitting layer in close contact with the inner surface of the thermally-conductive shell and for maximizing cooling of the photovoltaic cell;

providing pressure by a pneumatic chamber maintained at a controlled pressure on a coolant chamber, a heat sink in contact with the pressurized chamber containing liquid metal, the photovoltaic cell, the radiation-emitting layer, and the thermally-conductive shell for further maximizing cooling of the photovoltaic cell; and

circulating coolant liquid through cavities in the heat sink and the coolant chamber through use of flexible bellows and a coolant liquid distribution housing.

2. The method of claim 1, further comprising creating a vacuum between the emitting surface and the receiving surface for minimizing heat conduction.

3. The method of claim 2, wherein the vacuum is less than 10^{-3} Torr (0.1333 Pa).

4. The method of claim 1, further comprising maintaining a vacuum inside of the shell.

5. The method of claim 1 wherein the distance between the receiving surface of the photovoltaic cell and the emitting surface of the radiation-emitting layer is between 0.10 and 0.30 microns ($1x10^{-7}$m and $3x10^{-7}$m).

6. The method of claim 1, further comprising maintaining the distance between the receiving surface of the photovoltaic cell and the emitting surface of the radiation-emitting layer by use of thermally insulated spacers.

7. The method of claim 1, further comprising interposing a thermal interface between the collecting surface of a radiation-emitting layer and the inner surface of the thermally-conductive shell.

8. The method of claim 7, wherein the thermal interface comprises thermally conductive graphite.

10. An apparatus for converting heat energy to electric power using sub-micron gap thermo photovoltaic technology, comprising:

a collecting surface of a radiation-emitting layer for collecting heat energy from an inner surface of a thermally-conductive shell, an outer surface of the thermally-conductive shell being exposed to a heat energy source;

a receiving surface of a photovoltaic cell being maintained at less than one micron distance from an emitting surface of the radiation-emitting layer by spacers in a micro gap;

electromagnetic radiation being received by the receiving surface from the emitting surface;

the photovoltaic cell being pressurized by a thermally conductive, deformable foil membrane forming a wall of a pressurized liquid metal chamber containing liquid metal for keeping the collecting surface of the radiation-emitting layer in close contact with the inner surface of the thermally-conductive shell and for maximizing cooling of the photovoltaic cell;

a pneumatic chamber maintained at a controlled pressure on a coolant chamber, a heat sink being in contact with the pressurized chamber containing liquid metal for applying pressure on the photovoltaic cell, the radiation-emitting layer, and the thermally-conductive shell for further maximizing cooling of the photovoltaic cell; and

flexible bellows and a coolant liquid distribution housing for circulating coolant liquid through cavities in the heat sink and the coolant chamber.

11. The apparatus of claim 10, further comprising interposing a thermal interface between the collecting surface of a radiation-emitting layer and the inner surface of the thermally-conductive shell.

12. The apparatus of claim 10, further comprising a thermal interface between a high-temperature housing and a hot-side emitter comprised of thermally conductive graphite.

13. The apparatus of claim 10, wherein a vacuum is maintained between the emitting surface and the receiving surface.

14. The apparatus of claim 10, wherein a vacuum is maintained within the shell.

15. The apparatus of claim 10, further comprising thermally insulated spacers for maintaining the distance between the receiving surface of the photovoltaic cell and the emitting surface of the radiation-emitting layer.

16. An apparatus for converting heat energy to electric power using sub-micron gap thermo photovoltaic technology, comprising a shell for enclosing the components of a module, including:

an emitter chip array maintained in close thermal contact with the shell via a thermal interface;

a membrane and photovoltaic subassembly spaced apart from the emitter chip array by thermally insulated spacers;

a liquid metal chamber in contact with the membrane for maintaining the emitter chip array in thermal contact with the shell;

a heat sink subassembly for accepting liquid coolant for cooling the membrane, a liquid metal chamber and the photovoltaic subassembly;

a water distribution housing for distributing liquid coolant to the heat sink subassembly via a bellows subassembly;

a pneumatic subassembly for maintaining the heat sink in contact with the liquid metal chamber and photovoltaic subassembly; and

a pressure actuator for maintaining pressure in the pneumatic subassembly.

17. The apparatus of claim 16, wherein a vacuum is maintained within the shell.

18. The apparatus of claim 16, wherein the module contains a multiplicity of photovoltaic and emitter chip arrays.

19. The apparatus of claim 16, wherein a shell comprises an *M x N* array of modules, where *M* and *N* are greater than or equal to one.

20. The apparatus of claim 16, further comprising a cooling control module, a vacuum control module and a pneumatic pressure control module.

CLAIMS

1. A method for converting heat energy to electric power using sub-micron gap thermo photovoltaic technology, comprising the steps of:

collecting heat energy by a collecting surface of a radiation-emitting layer from an inner surface of a thermally-conductive shell, an outer surface of the thermally-conductive shell being exposed to a heat energy source;

maintaining a receiving surface of a photovoltaic cell by spacers in a micro gap less than one micron distance from an emitting surface of the radiation-emitting layer;

receiving electromagnetic radiation by the receiving surface from the emitting surface;

providing pressure on the photovoltaic cell by a thermally conductive, deformable foil membrane forming a wall of a pressurized chamber containing liquid metal for keeping the collecting surface of the radiation-emitting layer in close contact with the inner surface of the thermally-conductive shell and for maximizing cooling of the photovoltaic cell;

providing pressure by a pneumatic chamber maintained at a controlled pressure on a coolant chamber, a heat sink in contact with the pressurized chamber containing liquid metal, the photovoltaic cell, the radiation-emitting layer, and the thermally-conductive shell for further maximizing cooling of the photovoltaic cell; and

circulating coolant liquid through cavities in the heat sink and the coolant chamber through use of flexible bellows and a coolant liquid distribution housing.

2. The method of claim 1, further comprising creating a vacuum between the emitting surface and the receiving surface for minimizing heat conduction.

3. The method of claim 2, wherein the vacuum is less than 10^{-3} Torr (0.1333 Pa).

4. The method of claim 1, further comprising maintaining a vacuum inside of the shell.

5. The method of claim 1 wherein the distance between the receiving surface of the photovoltaic cell and the emitting surface of the radiation-emitting layer is between 0.10 and 0.30 microns ($1x10^{-7}$m and $3x10^{-7}$m).

6. The method of claim 1, further comprising maintaining the distance between the receiving surface of the photovoltaic cell and the emitting surface of the radiation-emitting layer by use of thermally insulated spacers.

7. The method of claim 1, further comprising interposing a thermal interface between the collecting surface of a radiation-emitting layer and the inner surface of the thermally-conductive shell.

8. The method of claim 7, wherein the thermal interface comprises thermally conductive graphite.

9. An apparatus for converting heat energy to electric power using sub-micron gap thermo photovoltaic technology, comprising:

a collecting surface of a radiation-emitting layer for collecting heat energy from an inner surface of a thermally-conductive shell, an outer surface of the thermally-conductive shell being exposed to a heat energy source;

a receiving surface of a photovoltaic cell being maintained at less than one micron distance from an emitting surface of the radiation-emitting layer by spacers in a micro gap;

electromagnetic radiation being received by the receiving surface from the emitting surface;

the photovoltaic cell being pressurized by a thermally conductive, deformable foil membrane forming a wall of a pressurized liquid metal chamber containing liquid metal for keeping the collecting surface of the radiation-emitting layer in close contact with the inner surface of the thermally-conductive shell and for maximizing cooling of the photovoltaic cell;

a pneumatic chamber maintained at a controlled pressure on a coolant chamber, a heat sink being in contact with the pressurized chamber containing liquid metal for applying pressure on the photovoltaic cell, the radiation-emitting layer, and the thermally-conductive shell for further maximizing cooling of the photovoltaic cell; and

flexible bellows and a coolant liquid distribution housing for circulating coolant liquid through cavities in the heat sink and the coolant chamber.

10. The apparatus of claim 9, further comprising interposing a thermal interface between the collecting surface of a radiation-emitting layer and the inner surface of the thermally-conductive shell.

11. The apparatus of claim 9, further comprising a thermal interface between a high-temperature housing and a hot-side emitter comprised of thermally conductive graphite.

12. The apparatus of claim 9, wherein a vacuum is maintained between the emitting surface and the receiving surface.

13. The apparatus of claim 9, wherein a vacuum is maintained within the shell.

14. The apparatus of claim 9, further comprising thermally insulated spacers for maintaining the distance between the receiving surface of the photovoltaic cell and the emitting surface of the radiation-emitting layer.

15. An apparatus for converting heat energy to electric power using sub-micron gap thermo photovoltaic technology, comprising a shell for enclosing the components of a module, including:

an emitter chip array maintained in close thermal contact with the shell via a thermal interface;

a membrane and photovoltaic subassembly spaced apart from the emitter chip array by thermally insulated spacers;

a liquid metal chamber in contact with the membrane for maintaining the emitter chip array in thermal contact with the shell;

a heat sink subassembly for accepting liquid coolant for cooling the membrane, the liquid metal chamber and the photovoltaic subassembly;

a water distribution housing for distributing liquid coolant to the heat sink subassembly via a bellows subassembly;

a pneumatic subassembly for maintaining the heat sink in contact with the liquid metal chamber and photovoltaic subassembly; and

a pressure actuator for maintaining pressure in the pneumatic subassembly.

16. The apparatus of claim 15, wherein a vacuum is maintained within the shell.

17. The apparatus of claim 15, wherein the module contains a multiplicity of photovoltaic and emitter chip arrays.

18. The apparatus of claim 15, wherein the shell comprises an *M x N* array of modules, where *M* and *N* are greater than or equal to one.

19. The apparatus of claim 15, further comprising a cooling control module, a vacuum control module and a pneumatic pressure control module.