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A HEAT EXTRACTOR

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Field Of Invention

The present invention relates generally to a heat extractor. In particular, the invention relates a heat extractor for rapidly dissipating concentration of heat generated by semiconductor devices.

Background

Improvements in performance and multi-functionality of electronic systems are unavoidably accompanied by increment in power dissipation thereof. The power dissipation is projected to reach 100~200 W/cm^2 in coming years for high performance integrated circuit (IC) chips, thereby presenting great challenges in thermal management. Therefore, large amount of heat must be effectively removed from the IC chips to maintain the chip temperature below a pre-defined temperature threshold, for example 85 °C, to guarantee performance and reliability. Conventional air-cooling technology cannot meet the high power dissipation requirements of high performance chips. Temperature reduction is also required for high power laser diode arrays mounted on sub-mounts and with power dissipation at or exceeding $200W/cm^2$ based on the footprint of the sub-mount. The laser diode array requires operation at a certain temperature, for example 70 °C, with minimal temperature variation ~10 °C across the laser diodes.

Typically, forced convection liquid cooling with water, dielectric liquid (for example FC 72) or the like coolants is utilised for removing the massive amount of heat generated from electronic devices.

United States Patent 5,731,954 by Cheon describes a heat extractor having one or more heat exchangers mounted onto heat-producing components in a computer system. Coolant is pumped through the one or more heat exchangers for removing heat therefrom. Heat is then transferred by the coolant away from the one or more heat exchangers to an array of cooling fins whereat heat from the coolant gathers for air-cooling. The heat exchanger in Cheon comprises a housing with a plurality of divider walls therein for dividing yet communicating coolant flow between an inlet

and an outlet of the heat exchanger. Each of the one or more heat exchangers of Cheon is miniaturized, resulting in enhanced thermal conductivity but large flow resistance. Flow resistance compromises the heat removal capability of the heat extractor.

Micro-channel heat sinks have been proven to be capable of removing heat generated from high power dissipation. Typical silicon micro-channel heat sinks are typically made through bulk etching technique. Alternatively, micro-channel heat sinks of metallic material are made through bulk milling processes. Effective micro-channel heat sinks require advanced fabrication techniques for producing flow channels with sizes within a range of 0.05~0.2 mm and aspect ratio of at least 10. However, the micro-channels are featured by bulk removal processes which are time-consuming and expensive.

Instead, a metallic form structure can be used as a cost-effective alternative to the micro-channel heat sink. The highly porous metallic foam structure is a good heat dissipating structure. Copper or aluminum foam structures with large bulk-height to pore-size ratio, also commonly known as the aspect ratio, can be obtained through available manufacturers through sophisticated foam manufacturing techniques. The general porosity of the metallic foam, for example a copper foam structure, is within a range of 0.9 to 0.8. This highly porous structure allows fluid to flow through the structure with reduced flow resistances. The foam material can also be mechanically compressed to achieve porosities within a range of 0.7 to 0.6. Non-metal foam such as Graphite foam can be used due to the high thermal conductivity of the material used. The porous structure provides a larger heat exchange area within the same volume compared with the finned heat sinks.

United States Patent 6,397,450 B1 (Ozmat1), United States Patent 6,196,307 B1 (Ozmat2) and United States Patent 5,402,004 (Ozmat3) describe use of a metallic foam structure for sinking heat generated by a heat source. In Ozmat1, Ozmat2 and Ozmat3, fluid is directed through the foam structure in a direction perpendicular to the direction of heat transfer for heat removal.

However, the implementations in Ozmat1, Ozmat2 and Ozmat3 results in high resistance to fluid flow and therefore lower volume flow rate through the foam structure. Lowering the volume flow rate consequently results in a lower rate of heat transfer between the fluid and the foam structure and slower heat removal from the foam structure. Increasing the volume flow rate would require a larger pump for creating a higher pressure-head at the foam structure. The larger pump and higher power requirement is inefficacious when implemented within a portable computing device, for example, a notebook.

Hence, this clearly affirms a need for a heat extractor for improving heat transfer and therefore heat removal without increasing space and power requirements.

Summary

In accordance with a first aspect of the invention, there is disclosed a heat extractor comprising:

a foam structure having a surface and a plurality of pores formed on the surface thereof, the plurality of pores being interconnected by a plurality of ducts for fluid communication therebetween, the foam structure for establishing thermal communication with a heat generator along a thermal plane, the thermal plane having a thermal nucleus whereat heat is concentrated when heat is generated from the heat generator; and

at least one barrier being shaped and dimensioned for blocking at least a portion of the plurality of pores for forming an intake and at least one exhaust on the surface of the foam structure, the intake and the at least one exhaust comprising at least one of the plurality of pores being unblocked by the at least one barrier,

whereby when fluid is introduced into the foam structure through the intake generally along an inlet axis coincident with the thermal nucleus, the fluid is subsequently being redirected away from the inlet axis in a plurality of dispersion directions substantially along the thermal plane for creating an impinging flow condition, the inlet axis being generally perpendicular to the thermal plane,

wherein heat generated by the heat generator is dissipated by the fluid flowing from the thermal nucleus along the thermal plane towards the at least one exhaust.

In accordance with a second aspect of the invention, there is disclosed a heat extraction process comprising the steps of:

providing a foam structure having a surface and a plurality of pores formed on the surface thereof, the plurality of pores being interconnected by a plurality of ducts for fluid communication therebetween, the foam structure for establishing thermal communication with a heat generator along a thermal plane, the thermal plane having a thermal nucleus whereat heat is concentrated when heat is generated from the heat generator;

providing at least one barrier being shaped and dimensioned for blocking at least a portion of the plurality of pores for forming an intake and at least one exhaust on the surface of the foam structure, the intake and the at least one exhaust comprising at least one of the plurality of pores being unblocked by the at least one barrier;

introducing fluid into the foam structure through the intake generally along an inlet axis coincident with the thermal nucleus; and

subsequently redirecting the fluid away from the inlet axis in a plurality of dispersion directions substantially along the thermal plane for creating an impinging flow condition, the inlet axis being generally perpendicular to the thermal plane,

wherein heat generated by the heat generator is dissipated by the fluid flowing from the thermal nucleus along the thermal plane towards the at least one exhaust.

Brief Description Of The Drawings

Embodiments of the invention are described hereinafter with reference to the following drawings, in which:

FIG. 1a illustrates a straight flow condition through a foam structure received in a straight-flow housing;

FIG. 1b illustrates an impinging flow condition through the foam structure of FIG. 1 received in an impinging flow housing;

FIG. 2 shows a partial front sectional view of a heat extractor according to a first embodiment of the invention with a foam structure being received within a housing and having one intake and two exhausts;

FIG. 3a shows a partial plan view of view A of the heat extractor of FIG. 2;

FIG. 3b shows a partial plan sectional view of view X-X of the heat extractor of FIG. 2;

FIG. 4 shows a system configuration and fluid flow diagram of the heat extractor of FIG. 2;

FIG. 5 shows a partial front sectional view of the heat extractor of FIG. 2 according to a second embodiment of the invention with the foam structure and a heat generator being received within the housing;

FIG. 6 shows a partial front sectional view of the heat extractor of FIG. 2 according to a third embodiment of the invention with a passageway formed adjacent to the foam structure;

FIG. 7 shows a plan view of view B of the heat extractor of FIG. 6;

FIG. 8 shows a partial plan sectional view of view C-C of the heat extractor of FIG. 6; and

FIG. 9 shows a partial front sectional view of the heat extractor of FIG. 2 according to a fourth embodiment of the invention with two foam structures received within a housing being mounted to two heat generators.

Detailed Description

A heat extractor is described hereinafter for addressing the foregoing problems.

A typical foam structure has a surface with a plurality of pores formed uniformly thereon. The pores are interconnected by ducts for enabling fluid communication between the pores with the ducts being formed by interconnected ligaments made from materials having high thermal conductivity, for example, metals or graphite carbon. A heat transfer coefficient h, describing the heat transfer efficiency of the foam structure, can be expressed as:

$$h=CK_{eff}\,Re^{a}/d_p \qquad (1)$$

In Equation 1, Re is the pore Reynolds number in relation to the pore dimension d_p and the bulk velocity V_D (also typically known as Darcy velocity) where $Re = V_D dp/\nu$ with ν being the kinematic viscosity of the fluid, dp being the pore size and Keff being the effective thermal conductivity. Keff is typically expressed as:

$$K_{eff} = K_{stag}+C_1 V_D \qquad (2)$$

In Equation 2, Kstag is the stagnant thermal conductivity in relation to the morphology, the material and the porosity of the foam structure. It is observable that a higher fluid velocity leads to a higher heat transfer coefficient. In addition, the power index a in Eq. (1) relates to the flow configuration. An impinging flow condition results in a high value a, leading to a high heat transfer coefficient for large Re flows.

When the foam structure is used for heat extraction, a pump is required to provide a pressure head for overcoming the flow resistance through the foam structure. When integrated with a computer system, the pump should have low power consumption and a small size. To reduce the flow resistance, an impinging flow condition within the foam structure is created with one fluid intake and a fluid exhaust arrangement for

discharging the fluid in at least two directions for reducing pressure drop across the foam structure. The pressure drop ΔP across the foam structure is described by:

$$\Delta P=AV_D+B\,V_D^2 \qquad (3)$$

Creating an impinging flow condition results in smaller coefficients A and B and thus smaller ΔP. Therefore, a higher velocity can be obtained at the same pressure drop to thereby achieve a more efficient heat transfer.

FIG. 1a illustrates a straight flow through a foam structure 1000 with a length L. The foam structure 1000 is received within a housing 1002 coupled to a heat generator 1004. An interface material 1006, for example a thermal interface material, interfaces the housing 1002 and the heat generator 1004. The straight flow of illustrated by FIG. 1a enters through the intake 1008 and exits from the exhaust 1010 of the foam structure 1000. The pressure drop for porous structure with homogeneous structure can be obtained based on the following general equation:

$$\frac{dp}{dx}=-\frac{\mu}{K}V_D-\frac{\rho_f C_F}{\sqrt{K}}V_D^2 \qquad (4)$$

In Equation 4, p is the pressure, x is the coordinate along a flow direction, K is the permeability of the foam structure and C_F is the inertial coefficient, with V_D being the bulk mean velocity or the Darcy velocity, μ being the dynamic viscosity and ρ being the density of the fluid. Equation 4 can be rearrange to obtain the pressure drop across the length L:

$$\Delta p_a=(AV_D+BV_D^2)L \qquad (5)$$

with $$A=\frac{\mu}{K} \qquad (6), \text{ and}$$

$$B = \frac{\rho C_F}{\sqrt{K}} \qquad (7)$$

An impinging flow condition is illustrated in FIG. 1b showing a foam structure 1012 being received within a housing 1014 and having an intake 1016 and two exhausts 1018. The housing 1014 is coupled to the heat generator 1004 of FIG. 1a with the interface material 1006 interfacing the housing 1014 and the heat generator 1004. Fluid flow entering through the intake 1016 and exits from the exhausts 1018 of the foam structure 1012 creates the impinging flow condition. Additionally, the fluid flow is directed towards a thermal nucleus 1020 whereat heat concentration is the highest.

For the impinging flow condition where flow through the foam structure is divided into at least two different flow directions, as illustrated in FIG. 1b, the pressure drop is approximated as:

$$\frac{\Delta p_b}{L/2} = A\frac{V_D}{2} + B\frac{V_D}{4}^2 \qquad (8)$$

$$\Delta p_b = \frac{L}{4}(AV_D + B\frac{V_D}{2}^2) < \frac{1}{4}\Delta p_a \qquad (9)$$

It is apparent from Equation 9 that the impinging flow condition results in a substantially lower pressure drop as compared to a straight flow condition through the same foam structure.

A first embodiment of the invention, a heat extractor 20 for dissipating heat from an electronic system is described with reference to FIG. 2, which shows a front elevation of the heat extractor 20, FIG. 3a, which shows a partial plan view of view A of FIG. 2, and FIG. 3b, which shows a partial plan sectional view of view X-X of FIG. 2.

As shown in FIG. 2, the heat extractor 20 comprises a foam structure 22 and a housing 24. The foam structure 22 has a surface with a plurality of pores formed

thereon. The pores are interconnected by ducts for enabling fluid communication between the pores with the ducts being formed by interconnected ligaments. The pores are preferably for creating a turbulent flow within the foam structure 22 when fluid passages therethrough. The foam structure 22 is typically metallic for facilitating thermal conductivity thereof. Alternatively, the foam structure 22 is made from graphite having good thermal conductivity. Preferably, the foam structure 20 has a pore density within a range of 50 to 150 pores per inch (ppi).

The foam structure 22 is enclosed in the housing 24. The housing 24 forms at least one barrier for blocking a portion of the plurality of pores. The at least one barrier forms an intake 32, a first exhaust 34 and a second exhaust 36. Each of the intake 32 and the first exhaust 34 having at least one of the plurality of pores being unblocked by the at least one barrier formed by the housing 32. Preferably, the housing 24 can be disassembled for removing or replacing the foam structure 22 therewithin. The foam structure 22 is bondable with the housing 24 using conventional bonding techniques, for example, brazing, soldering or adhesive bonding. Preferably, spring-loaded fasteners (not shown) secure the housing 24 with, for example, an electronic package (also not shown).

The foam structure 22 is preferably box-shaped. The first exhaust 34 and the second exhaust 36 are formed on two outwardly opposing faces of the foam structure 22. The intake 32 is formed on a face adjacent to both the first exhaust 34 and the second exhaust 36.

The housing 24 is preferably coupled to a heat generator 38, for example, a microprocessor. An interface material 40 interfaces the housing 24 and the heat generator 38 for facilitating thermal communication between the heat generator 38 and the foam structure 22 enclosed within the housing 24. The interface material 40 is a thermal interface material in the first embodiment of the invention. Heat generated by the heat generator 38 is transferred to the foam structure 22 across a thermal plane 42. The thermal plane 42 has a thermal nucleus 44 whereat heat concentration is the highest.

The housing 24 comprises an inlet 46 being operatively aligned with the intake 32. When fluid is introduced into the foam structure 22 through the intake 32 via the inlet 46, the fluid passages in a first direction 200 along an inlet axis 48 towards the thermal nucleus 44. The inlet axis 48 is generally perpendicular to the thermal plane 42 and coincident with the thermal nucleus 44. When the fluid approaches the thermal plane 42, the fluid is redirected in any direction 202 substantially perpendicular to and away from the inlet axis 48 towards the first exhaust 34 and the second exhaust 36 for creating an impinging flow condition. Preferably, the fluid is redirected away from the inlet axis 48 in two generally outwardly opposing directions. The impinging flow condition allows heat generated by the heat generator 38 to be dissipated by the fluid flowing along the thermal plane 42 towards the first exhaust 34 and the second exhaust 36. Preferably, the inlet 46 has a rectangular cross-section.

The housing 24 further comprises a first outlet 50a and a second outlet 50b being operatively aligned with the first exhaust 34 and the second exhaust 36 respectively. Fluid discharged by the first exhaust 34 and the second exhaust 36 is subsequently conveyed away therefrom in a third direction 204 by the first outlet 50a and the second outlet 50b respectively. Preferably, each of the first outlet 50a and the second outlet 50b is circular in shape.

FIG. 4 shows a system flow diagram of the heat extractor 20. As heat along the thermal plane 42 is conducted to the fluid, the fluid exits the first and second outlets 50a/50b as heated fluid. The heat extractor 20 further comprises outlet conduits 52 extending between the first and second outlet 50a/50b and a heat exchanger 54. Heated fluid is carried from the first and second outlets 50a/50b, along the outlet conduit 52 and discharged into the heat exchanger 54.

A reservoir 56 is operationally disposed between the heat exchanger 54 and a pump 58. The heat extractor 20 further comprises an inlet conduit 60 extending between the pump 58 and the inlet 46 of the housing 24. The pump 58 is preferably a displacement pump for conveying heated fluid from the reservoir 56 to the inlet 46 of the housing 24, and the heat exchanger 54 is preferably air-cooled for extracting heat from and thereby cooling the heated fluid. Cooled fluid from the heat exchanger 54 is

conveyed along the inlet conduit 60 to the inlet 46 for reintroduction into the foam structure 22 through the intake 32.

A second embodiment of the invention, a heat extractor 20 as seen in FIG. 5 comprises of two main elements: a foam structure 22 and a housing 24. The descriptions in relation to the structural configurations of and positional relationships among the foam structure 22, the housing 24, the reservoir 54, the pump 56 and the heat exchanger 58 with reference to FIGS. 1 to 4 are incorporated herein.

In the second embodiment of the invention, the foam structure 22 is coupled to the heat generator 38 with the interface material (not shown in FIG. 5) interfacing the foam structure 22 and the heat generator 38, with the interface material being a bonding material. The bonding material is for bonding the foam structure 22 with the heat generator 38 and is preferably applied via conventional bonding techniques, for example, brazing or soldering. Both the foam structure 22 and the heat generator 38 are received within the housing 24. The heat generator 38 is, for example, a microprocessor in signal communication with a substrate (not shown) through the housing 24. The heat generator 38 cooperates with the housing 24 for forming a barrier on at least a portion of the surface of the foam structure 22 for forming the intake 32, the first exhaust 34 and the second exhaust 36. The thermal plane 42 is established along the interface between the foam structure 22 and the heat generator 38.

The operational principle of the heat extractor 20 is similar to that in the first embodiment of the invention. Fluid is introduced into the foam structure 22 through the intake 32. The fluid is directed in a first direction 206 along the inlet axis 48 towards the thermal nucleus 44 for establishing an impinging flow condition. Heat generated across the thermal plane 42 by the heat generator 38 is dissipated by the fluid redirected for flow along any direction 208 substantially perpendicular to the inlet axis 48 which conducts the heat away from the foam structure 22 when the fluid flows in a third direction 210 to the heat exchanger 58 for cooling and subsequently reintroduced into the foam structure 22 via the pump 58.

A third embodiment of the invention, a heat extractor 20 as seen in FIG. 6, FIG. 7 and FIG. 8, comprises of two main elements: a foam structure 22 and a housing 24. The descriptions in relation to the structural configurations of and positional relationships among the foam structure 22, the housing 24, the reservoir 54, the pump 56 and the heat exchanger 58 with reference to FIGS. 1 to 4 are incorporated herein.

Similar to the first embodiment, the foam structure 22 in the third embodiment is box-shaped. Alternatively, the foam structure 22 is cylindrically shaped. The box-shaped foam structure 22 has two outwardly opposing end-faces and four side-faces with each of the side faces being adjacent to both the end-faces. The foam structure 22 is received in the housing 24, with the housing forming barriers on one of the end-faces of the foam structure 22 to thereby form an intake 64 on one of the end faces. The four unblocked side faces combine to form an exhaust 66. A passageway 68 is formed in the housing 24 adjacent to the exhaust 66 as shown in FIGS. 6 and 8.

As shown in FIGS. 6 and 7, the housing 24 has an inlet 70 in fluid communication with the intake 64 and an outlet 72 in fluid communication with the passageway 68. As shown in FIG. 7, the inlet 70 has a circular cross-section. Fluid is introduced into the foam structure 22 through the inlet 64 via the intake of the foam structure 22. Flow of the fluid into the foam structure 22 is directed by the inlet 64 in a first direction 212 along the inlet axis 48 towards the thermal nucleus 44 of the thermal plane 42 interfacing the housing 24 and one of the end-faces of the foam structure 22.

An impinging flow condition is created when the fluid reaches the thermal plane 42 and is redirected in a second direction 214 away from the inlet axis 48 towards the exhaust 66. Fluid propagates away from the inlet axis 48 in an outwardly concentric manner. Heat generated by the heat generator 38 travels across the thermal plane 42 and is thermally conducted by the fluid flowing along the thermal plane 42 towards the exhaust 66.

Fluid discharged from the exhaust 66 into the passageway 68 travels in a third direction 216 towards the outlet 72. The fluid is then conveyed through the outlet 72

in a fourth direction 218 to the heat exchanger 58 for cooling and subsequently reintroduced into the foam structure 22 via the pump 58.

A fourth embodiment of the invention, a heat extractor 20 as seen in FIG. 9 comprises of three main elements: a first foam structure 80, a second foam structure 82 and a housing 84 shaped and dimensioned for receiving the first foam structure 80 and the second foam structure 82 therewithin. The descriptions in relation to the structural configurations of and positional relationships among the housing 24, the reservoir 54, the pump 56 and the heat exchanger 58 with reference to FIGS. 1 to 4 are incorporated herein.

In the fourth embodiment of the invention, the first foam structure 80 and the second foam structure are received within the housing 84 along a thermal plane 86. The housing 84 is coupled to a first heat generator 88 and a second heat generator 90, with the first foam structure 80 and the second foam structure 82 being proximal to the first heat generator 88 and the second heat generator 90 respectively. A thermal interface material 91 interfaces the housing 84 with each of the first heat generator 88 and the second heat generator 90 for improving thermal conductivity and thereby improving heat transfer therebetween.

When the first foam structure 80 and the second foam structure 82 are received within the housing 84, the housing 84 foams a barrier on a portion of the surface of each of the first foam structure 80 and the second foam structure 82 to expose a first intake 92, a first exhaust 94, a second intake 96 and a second exhaust 98. The first intake 92 and the first exhaust 94 are formed on the surface of the first foam structure 80, and the second intake 96 and the second exhaust 98 are formed on the surface of the second foam structure 82. Heat generated from both the first heat generator 88 and the second heat generator 90 is transferred across the thermal plane 86 to the first foam structure 80 and the second foam structure 82 respectively. Along the thermal plane 86, heat is concentrated at a first thermal nucleus 100 situated between the first heat generator 88 and the first foam structure 80, and at a second thermal nucleus 102 situated between the second heat generator 90 and the second foam structure 82.

Fluid from the reservoir 56 is conveyed to an inlet manifold 104 by the pump 58. The inlet manifold 104 is formed in the housing 84 and is for directing fluid to the first foam structure 80 and the second foam structure 82 via the first intake 92 and the second intake 96 respectively. Fluid enters the first foam structure 80 and the second foam structure 82 in a first direction 220 along a first inlet axis 106 towards the first thermal nucleus 100 and in a second direction 222 along a second inlet axis 108 towards the second thermal nucleus 102. The first inlet axis 106 and the second inlet axis 108 are coincident with the first thermal nucleus 100 and the second thermal nucleus 102 respectively, and generally perpendicular to the thermal plane 86.

The fluid entering the first foam structure 80 and the second foam structure 82 is subsequently redirected in any direction 224 substantially perpendicular to and away from the first inlet axis 106 and the second inlet axis 108 towards the first exhaust 94 and the second exhaust 94. An impinging flow condition is thereby created within each of the first foam structure 80 and the second foam structure 82. Heat is substantially conducted and carried away by the fluid travelling along the thermal plane towards the first exhaust 94 and the second exhaust 98. Fluid exits the first and second exhausts 94/98 into a passageway 110 formed adjacent thereto. The passageway 110 is in fluid communication with an outlet 112 for conveying the fluid thereto. Fluid leaves the housing 84 in a fourth direction 226 through the outlet 112 for conveyance to the reservoir 54.

The fluids used in the first, second, third and fourth embodiments of the invention are dielectric fluids, for example, a dielectric fluorocarbon fluid like FC-72. However, water is preferably used in replacement of the dielectric fluids in the first, third and fourth embodiments.

In the foregoing manner, a heat extractor is described according to four embodiments of the invention for addressing the foregoing disadvantages of conventional cooling devices. Although only three embodiments of the invention are disclosed, it will be apparent to one skilled in the art in view of this disclosure that numerous changes and/or modification can be made without departing from the scope and spirit of the invention.

Claims

1. A heat extractor for extracting heat from a heat generator, comprising:

a foam structure having a surface and a plurality of pores formed on the surface thereof, the plurality of pores being interconnected by a plurality of ducts for fluid communication therebetween, the foam structure for establishing thermal communication with a heat generator along a thermal plane, the thermal plane having a thermal nucleus whereat heat is concentrated when heat is generated from the heat generator; and

at least one barrier being shaped and dimensioned for blocking at least a portion of the plurality of pores for forming an intake and at least one exhaust on the surface of the foam structure, the intake and the at least one exhaust comprising at least one of the plurality of pores being unblocked by the at least one barrier,

whereby when fluid is introduced into the foam structure through the intake generally along an inlet axis coincident with the thermal nucleus, the fluid is subsequently being redirected away from the inlet axis in a plurality of dispersion directions substantially along the thermal plane for creating an impinging flow condition, the inlet axis being generally perpendicular to the thermal plane,

wherein heat generated by the heat generator is dissipated by the fluid flowing from the thermal nucleus along the thermal plane towards the at least one exhaust.

2. The heat extractor as in claim 1, the at least one barrier being formed by a housing for enclosing the foam structure therein, the housing having an inlet and at least one outlet, the inlet being shaped, dimensioned and positioned for directing fluid through the intake of the foam structure and the at least one outlet for removing fluid discharged from the at least one exhaust from the housing.

3. The heat extractor as in claim 2, the housing comprising a passageway formed adjacent to the exhaust of the foam structure for conveying fluid discharged therefrom to the at least one outlet.

4. The heat extractor as in claim 1, the plurality of dispersion directions comprising two outwardly opposing directions.

5. The heat extractor as in claim 1, the foam structure being coupled to the heat generator with a bonding material being disposed therebetween for facilitating heat transfer.

6. The heat extractor as in claim 1, the housing being coupled to the heat generator with a thermal interface material being disposed therebetween for facilitating heat transfer.

7. The heat extractor as in claim 6, the heat generator being disposed within the housing.

8. The heat extractor as in claim 1, the heat generator being at least one microprocessor device.

9. The heat extractor as in claim 1, wherein the foam structure is box-shaped.

10. The heat extractor as in claim 1, wherein the ducts within the foam structure is for creating a turbulent flow therein when fluid passages therethrough.

11. The heat extractor as in claim 2, the inlet being one of a circular channel and a square channel.

12. The heat extractor as in claim 1, the foam structure being one of metal and graphite material.

13. The heat extractor as in claim 1, the plurality of pores being formed at a pore density of within a range of 50 to 150 pores per inch.

14. A heat extraction process comprising the steps of:

providing a foam structure having a surface and a plurality of pores formed on the surface thereof, the plurality of pores being interconnected by a plurality of ducts for fluid communication therebetween, the foam structure for establishing thermal communication with a heat generator along a thermal plane, the thermal plane having a thermal nucleus whereat heat is concentrated when heat is generated from the heat generator;

providing at least one barrier being shaped and dimensioned for blocking at least a portion of the plurality of pores for forming an intake and at least one exhaust on the surface of the foam structure, the intake and the at least one exhaust comprising at least one of the plurality of pores being unblocked by the at least one barrier;

introducing fluid into the foam structure through the intake generally along an inlet axis coincident with the thermal nucleus; and

subsequently redirecting the fluid away from the inlet axis in a plurality of dispersion directions substantially along the thermal plane for creating an impinging flow condition, the inlet axis being generally perpendicular to the thermal plane,

wherein heat generated by the heat generator is dissipated by the fluid flowing from the thermal nucleus along the thermal plane towards the at least one exhaust.

15. The heat extraction process as in claim 14, the step of providing at least one barrier comprising the step of:

providing a housing for forming the at least one barrier for enclosing the foam structure therein, the housing having an inlet and at least one outlet, the inlet being shaped, dimensioned and positioned for directing fluid through the intake of the foam structure and the at least one outlet for removing fluid discharged from the at least one exhaust from the housing.

16. The heat extraction process as in claim 15, the step of providing a housing comprising the step of providing a housing with a passageway formed adjacent to the exhaust of the foam structure for conveying fluid discharged therefrom to the at least one outlet.

17. The heat extraction process as in claim 14, the step of subsequently redirecting the fluid away from the inlet axis in a plurality of dispersion directions comprising the step of:

subsequently redirecting the fluid away from the inlet axis in two outwardly opposing directions.

18. The heat extraction process as in claim 14, the step of providing a foam structure comprising the step of:

coupling the foam structure to the heat generator with a bonding material being disposed therebetween for facilitating heat transfer.

19. The heat extraction process as in claim 14, the step of providing a foam structure comprising the step of:

coupling the housing to the heat generator with a thermal interface material being disposed therebetween for facilitating heat transfer.

20. The heat extraction process as in claim 14, the step of providing a foam structure further comprising the step of:

disposing the heat generator within the housing.

21. The heat extraction process as in claim 14, the step of providing a foam structure comprising the step of providing a foam structure for coupling to at least one microprocessor device, the at least one microprocessor device constituting the heat generator.

22. The heat extraction process as in claim 14, the step of providing a foam structure comprising the step of providing a foam structure that is box-shaped.

23. The heat extraction process as in claim 14, the step of providing a foam structure comprising the step of providing a foam structure with ducts therewithin for creating a turbulent flow therein when fluid passages therethrough.

24. The heat extraction process as in claim 15, the step of providing a housing comprising the step of providing a housing with an inlet, the inlet being one of a circular channel and a square channel.

25. The heat extraction process as in claim 14, the step of providing a foam structure comprising the step of providing a foam structure being one of metal and graphite material.

26. The heat extraction process as in claim 14, the step of providing a foam structure comprising the step of providing a foam structure with a plurality of pores being formed at a pore density of within a range of 50 to 150 pores per inch.