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HIGH HEAT COOLING DEVICE

Abstract

A high heat cooling device includes a heat-conducting chamber body that has a heat-absorbing surface, a first chamber, and a second chamber. The first chamber is closer to the heat-absorbing surface than the second chamber. At least one isolation ring is disposed in the first chamber of the heat-conducting chamber body, dividing the first chamber into a primary hot zone and a secondary hot zone. The primary hot zone is not in fluid communication with the secondary hot zone, and the primary hot zone is surrounded by the isolation ring and is in communication with the second chamber.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This application is a non-provisional and claims priority under 35 U.S.C. § 120 to U.S. Provisional Application No. 63/552,149, filed Feb. 11, 2024, the contents are hereby incorporated by reference in their entirety.

TECHNICAL FIELD

[0002] The present disclosure relates to a high heat cooling device, in particularly to a high heat cooling device with two layers of heat dissipation chambers.

BACKGROUND OF THE INVENTION

[0003] The technical principle of the vapor chamber is similar to that of a heat pipe, but with a different heat conduction method. While the heat pipe conducts heat on a one-dimensional surface, the vapor chamber conducts heat more efficiently because it does so on a two-dimensional surface. Specifically, the vapor chamber comprises a chamber body and a capillary structure. The chamber body includes a hollow chamber filled with a working fluid, and the capillary structure is arranged within the hollow chamber. The heated area of the chamber body is called the evaporation zone, while the area that dissipates heat is called the condensation zone. The working fluid absorbs heat in the evaporation zone and vaporizes. And, the vaporized working fluid rapidly flows throughout the chamber body. The heat from the vaporized working fluid is released in the condensation zone and condensed back into a liquid state. The liquid working fluid then returns to the evaporation zone through the capillary structure, creating a cooling cycle.

[0004] Most vapor chambers and heat pipes operate independently, namely conducting only flat or linear heat transfer rather than overall three-dimensional heat transfer. This limits the heat dissipation efficiency. Manufacturers have integrated vapor chambers and heat pipes to create devices capable of conducting three-dimensional heat transfer However, with the rapid development of high-speed computing technologies like artificial intelligence, there is an increasing demand for better heat dissipation in electronic components. The current three-dimensional heat transfer devices cannot properly manage the heat generated during operation. It causes partial dry burning, leading to a decline in function the three-dimensional heat transfer devices. Therefore, it is crucial for R&D personnel to find solutions to prevent functional degradation and maintain the heat dissipation performance of the three-dimensional heat transfer devices.

SUMMARY

[0005] A variety of additional inventive aspects will be set forth in the description that follows. The inventive aspects can relate to individual features and to combinations of features. It is to be understood that both the forgoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the broad inventive concepts upon which the embodiments disclosed herein are based.

[0006] In an embodiment of the present disclosure, a high heat cooling device includes a heat-conducting chamber body having a heat-absorbing surface, a first chamber, and a second chamber, wherein the first chamber is closer to the heat-absorbing surface than the second chamber, and at least one isolation ring disposed in the first chamber of the heat-conducting chamber body, dividing the first chamber into a primary hot zone and a secondary hot zone, wherein the primary hot zone is not in communication with the secondary hot zone, and the primary hot zone is surrounded by the isolation ring and is in communication with the second chamber.

[0007] In an embodiment of the present disclosure, the primary hot zone and the secondary hot zone are filled with different types of cooling fluid.

[0008] In an embodiment of the present disclosure, the freezing point of the cooling fluid in the primary hot zone is lower than that of the cooling fluid in the secondary hot zone.

[0009] In an embodiment of the present disclosure, a cooling fluid filling rate in the primary hot zone is different from that in the secondary hot zone.
[0010] In an embodiment of the present disclosure, the cooling fluid filling rate in the primary hot zone is greater than that in the secondary hot zone.
[0011] In an embodiment of the present disclosure, the area of the primary hot zone is equal to or greater than 5% of the heat source area, and less than or equal to 80% of the heat source area.
[0012] In an embodiment of the present disclosure, the cooling fluid filling rate in the primary hot zone is equal or greater than 60% of the volume of the capillary pore, and the cooling fluid filling rate in the secondary hot zone is at least 50% of the volume of the capillary pore and does not exceed 130% of the volume of the capillary pore.
[0013] In an embodiment of the present disclosure, the high heat cooling device further includes a plurality of primary hot zone heat pipes, wherein the plurality of primary hot zone heat pipes are disposed in the heat-conducting chamber body and are in fluid communication with the second chamber and the primary hot zone of the first chamber.
[0014] In an embodiment of the present disclosure, at least one primary hot zone heat pipes is positioned outside of the first region that is an area right above the heat-absorbing surface in the heat-conducting chamber body.
[0015] In an embodiment of the present disclosure, the high cooling device further includes a plurality of secondary hot zone heat pipes, wherein the secondary hot zone heat pipes are disposed in the heat-conducting chamber body and communicated to the secondary hot zone of the first chamber.
[0016] The high heat cooling device according to claim **10**, the secondary hot zone heat pipes are configured to be positioned entirely within the first region, entirely outside of the first region, or in a configuration where some secondary hot zone heat pipes are within in the first region while others are positioned outside of the first region.
[0017] In an embodiment of the present disclosure, at least one primary hot zone heat pipe is located on a side of the heat-conducting chamber body along a longitudinal axis.
[0018] In an embodiment of the present disclosure, the heat-conducting chamber body includes an air inlet side edge, and the distance from the air inlet edge to the nearest primary hot zone heat pipe is less than or equal to one-third of the length of the longitudinal axis of the heat-conducting chamber body.
[0019] In an embodiment of the present disclosure, a portion of the plurality of primary hot zone heat pipes are located adjacent to the air inlet side edge.
[0020] In an embodiment of the present disclosure, the high heat cooling device further includes a plurality of primary hot zone heat pipes, wherein at least one primary hot zone heat pipe is in fluid communication with the primary hot zone, and the number of the primary hot zone heat pipes located on the side adjacent to the air inlet side edge along the longitudinal axis of the heat-conducting chamber body is greater than or equal to 10% of the total number of the primary hot zone heat pipes and the hot zone heat pipes combined together.
[0021] In an embodiment of the present disclosure, the high heat cooling device further includes a first heat-conducting casing, a second heat-conducting casing, and at least one partition plate having at least one opening, wherein the partition plate is arranged between the first-heat conducting casing and the second heat-conducting casing, the first chamber and the second chamber are formed by coupling the first heat-conducting casing, the second heat-conducting casing and the partition plate and are located on opposite sides of the partition plate, the heat-absorbing surface is located on a side of the first heat-conducting casing and is further away from the second heat-conducting casing, the isolation ring having a first end and a second end connect to the first heat-conducting casing and the partition plate, respectively, the primary hot zone is communicated to the second chamber via an opening.
[0022] In an embodiment of the present disclosure, the thickness of the partition plate is equal to or

greater than 0.1 mm and less than or equal to 5 mm.
[0023] In an embodiment of the present disclosure, a capillary structure is disposed in both the first chamber and the second chamber.
[0024] In an embodiment of the present disclosure, a capillary structure is only disposed on the secondary hot zone of the first chamber.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0025] Unless specified otherwise, the accompanying drawings illustrate aspects of the innovative subject matter described herein. Referring to the drawings, wherein like reference numerals indicate similar parts throughout the several views, several examples of high heat cooling devices and methods incorporating aspects of the presently disclosed principles are illustrated by way of example, and not by way of limitation.
[0026] The accompanying drawings, which are incorporated in and constitute a part of the description, illustrate several aspects of the present disclosure. A brief description of the drawings is as follows.
[0027] FIG. **1** is a schematic perspective view of a high heat cooling device according to one embodiment of the present invention.
[0028] FIG. **2** is an exploded schematic view of the high heat cooling device of FIG. **1**.
[0029] FIG. **3** is a partially enlarged three-dimensional schematic view of the high heat cooling device of FIG. **1**.
[0030] FIG. **4** is a partially enlarged exploded view of the high heat cooling device of FIG. **1**.
[0031] FIG. **5** is a schematic plan view of the heat-conducting chamber body of the high heat cooling device of FIG. **1**.
[0032] FIG. **6** is a schematic plan view of the high heat cooling device of FIG. **1**.
[0033] FIG. **7** is a schematic cross-sectional view of a high heat cooling device along the line **7-7** of FIG. **6**.
[0034] FIG. **8** is a schematic cross-sectional view of two cooling fluids flowing in the first chamber and the second chamber respectively in the high heat cooling device of FIG. **1**.
[0035] FIG. **9** is an exploded schematic diagram of a high heat cooling device according to one embodiment of the present disclosure.
[0036] FIG. **10** is a partially enlarged three-dimensional schematic view of the high heat cooling device of FIG. **9**.
[0037] FIG. **11** is a partially enlarged exploded view of the high heat cooling device of FIG. **9**.
[0038] FIG. **12** is a schematic plan view of the heat-conducting chamber body of the high heat cooling device of FIG. **9**.
[0039] FIG. **13** is a schematic plan view of the high heat cooling device of FIG. **9**.
[0040] FIG. **14** is a schematic cross-sectional view of a high heat cooling device along line **14-14** of FIG. **13**.
DETAILED DESCRIPTION
[0041] The following describes various principles related to high heat cooling devices and methods by way of reference to specific examples of vapor chambers and heat pipes including specific arrangements and examples of ‘vapor chamber and heat pipe elements described herein’ embodying innovative concepts. More particularly, but not exclusively, such innovative principles are described in relation to selected examples of ‘vapor chamber and heat pipe elements described herein’ systems and methods, and well-known functions or constructions are not described in detail for purposes of succinctness and clarity. Nonetheless, one or more of the disclosed principles can be incorporated in various other embodiments of ‘vapor chamber and heat pipe elements described

herein' systems and methods to achieve any of a variety of desired outcomes, characteristics, and/or performance criteria.

[0042] Thus, "vapor chamber and heat pipe elements described herein" systems and methods having attributes that are different from those specific examples discussed herein can embody one or more of the innovative principles and can be used in applications not described herein in detail. Accordingly, embodiments of 'vapor chamber and heat pipe elements described herein' systems and methods not described herein in detail also fall within the scope of this disclosure, as will be appreciated by those of ordinary skill in the relevant art following a review of this disclosure.

[0043] Referring to FIGS. **1-4**. FIG. **1** is a schematic perspective view of a high heat cooling device according to one embodiment of the present invention. FIG. **2** is an exploded schematic view of the high heat cooling device of FIG. **1**. FIG. **3** is a partially enlarged three-dimensional schematic view of the high heat cooling device of FIG. **1**. FIG. **4** is a partially enlarged exploded view of the high heat cooling device of FIG. **1**.

[0044] In one embodiment, the high heat cooling device **10** is used for thermal coupling with a heat source (not shown). The heat source is, for example, a system that includes multiple heating chips or local hot spot in one chip. The high heat cooling device **10** includes a heat-conducting chamber body **11**, an isolation ring **12**, a plurality of primary hot zone heat pipes **13** and a plurality of secondary hot zone heat pipes **14**. The heat-conducting chamber body **11** includes a first heat-conducting casing **111**, a second heat-conducting casing **112** and a partition plate **113**.

[0045] The partition plate **113** is arranged between the first heat-conducting casing **111** and the second heat-conducting casing **112**, and the thickness of the partition plate **113** is, for example, equal to or greater than 0.1 mm and less than or equal to 5 mm. The heat-conducting chamber body **11** has a heat-absorbing surface **114**. The heat-absorbing surface **114** is thermally coupled to the heat source. Specifically, the heat-absorbing surface **114** refers to the area of the thermal contact area between the first heat-conducting casing **111** and the heat source. In one embodiment, the heat-absorbing surface **114** is smaller than the area of the bottom of the first heat-conducting casing **111**. In another embodiment, the heat-absorbing surface **114** is located in the center area of the bottom of the first heat-conducting casing **111**. The heat-absorbing surface **114** is located on a side of the first heat-conducting casing **111** and is further away from the second heat-conducting casing **112**. Additionally, the first heat-conducting casing **111**, the second heat-conducting casing **112** and the partition plate **113** are coupled to form a first chamber S**1** and a second chamber S**2**. The first chamber S**1** and the second chamber S**2** are respectively located on opposite sides of the partition plate **113**. In other words, the second chamber S**2** is stacked on the first chamber S**1**. The first chamber S**1** is closer to the heat-absorbing surface **114** than the second chamber S**2**.

[0046] Referring to FIGS. **5-7**. FIG. **5** is a schematic plan view of the heat-conducting chamber body of the high heat cooling device of FIG. **1**. FIG. **6** is a schematic plan view of the high heat cooling device of FIG. **1**. FIG. **7** is a schematic cross-sectional view of a high heat cooling device along the line **7-7** of FIG. **6**.

[0047] The isolation ring **12** is disposed in the first chamber S**1** of the heat-conducting chamber body **11**. The isolation ring **12** has two ends, one end connecting to the first heat-conducting casing **111** and the other end connecting to the partition plate **113** to divide the first chamber S**1** into a primary hot zone S**11** and a secondary hot zone S**12**. The primary hot zone S**11** and the secondary hot zone S**12** are not in communication. The primary hot zone S**11** is surrounded by the isolation ring **12** and is in communication with the second chamber S**2**. The isolation ring **12** is, for example, a separate component from the first heat-conducting casing **111** and the partition plate **113**, but the embodiment is not limited thereto. In other embodiments, the isolation ring can also be formed integrally by protruding from the first heat-conducting casing or the partition plate. The primary hot zone S**11** corresponds to the area with the highest heat density in the heat source, and the value of the heat density of the area with the highest heat density is, for example, 100 watts per square centimeter (W/cm.sup.2). Additionally, the partition plate **113** has an opening **1131**. The primary

hot zone S**11** is communicated to the second chamber S**2** via the opening **1131**.
[0048] The primary hot zone S**11** and the secondary hot zone S**12** are filled with different types of cooling fluids. For example, the cooling fluids may be water, alcohols such as methanol or ethanol, acetone, ammonia, and dielectric liquid such as fluorinated or refrigerant. Additionally, in an embodiment, a capillary structure **15** is disposed in both the first chamber S**1** and the second heat-conducting casing **112**. By disposing the capillary structure **15**, the cooling fluid can absorb heat from the heat source and can vaporize before flowing back through the capillary structure **15**. The capillary structure **15** in the primary hot zone S**11** can also be used to increase the boiling or evaporation surface area.
[0049] In one embodiment, the cooling fluids in the primary hot zone S**11** flows to the second chamber S**2** through the opening **1131**. The filling rate of the cooling fluid in the primary hot zone S**11** is, for example, greater than the filling rate of the cooling fluid in the secondary hot zone S**12**, but the embodiment is not limited thereto. The filling rate of the cooling fluid in the primary hot zone can also be less than or equal to the second hot zone. The filling rate refers to the ratio of the actual filling amount of the cooling fluid to the saturated filling amount of the cooling fluid, and the saturated filling amount of the cooling fluid refers to the product of the volume of the capillary structure, the porosity of the capillary structure and the density of the cooling fluid.
[0050] Further, the area of the primary hot zone S**11** is, for example, equal to or greater than 5% of the area of the heat-absorbing surface **114** and less than or equal to 80% of the area of the heat-absorbing surface **114**. That is to say, the area of the primary hot zone S**11** is, for example, equal to or greater than 5% of the area of the heat source area, and less than or equal to 80% of the area of the heat source area.
[0051] In one embodiment, the freezing point of the cooling fluid in the primary hot zone S**11** is, for example, lower than that of the cooling fluid in the secondary hot zone S**12**. For example, the cooling fluid in the secondary hot zone S**12** is water, and the cooling fluid in the primary hot zone S**11** is an alcohol such as methanol or ethanol, a dielectric liquid such as a fluorinated liquid, or a refrigerant with a lower freezing point than that of water. When the external temperature of the high heat cooling device **10** is lower than the freezing point of the cooling fluid in the secondary hot zone S**12**, the cooling fluid in the secondary hot zone S**12** changes to a solid state, and the cooling fluid in the primary hot zone S**11** can still maintain its liquid state and flow normally. Accordingly, the cooling fluid located in the primary hot zone S**11** can heat the solidified cooling fluid in the secondary hot zone S**12** so that the solidified cooling fluid in the secondary hot zone S**12** can melt into a liquid state and then resume normal flow.
[0052] The primary hot zone heat pipes **13** are disposed in the heat-conducting chamber body **11** and are in fluid communication with the second chamber S**2** and the primary hot zone S**11** of the first chamber S**1**. The heat-absorbing surface **114** and spaces right above it in the heat-conducting chamber body **11** define a first region. At least one of the primary hot zone heat pipes **13** is positioned outside the first region. In other words, at least one of the primary hot zone heat pipes **13** falls outside of the area right above heat-absorbing surface **114** in the heat-conducting chamber body **11**. In one embodiment, the primary hot zone heat pipes **13** are located on both edge sides of the heat-conducting chamber body **11** along a longitudinal axis L, so that the high cooling device **10** has a symmetrical design, thereby preventing installation person from incorrectly installing the high cooling device in a wrong direction. However, the embodiment is not limited thereto. In one embodiment, the primary hot zone heat pipes **13** are not arranged symmetrically. To enhance the efficiency of the fin utilization, the primary hot zone heat pipes **13** and the secondary hot zone heat pipes **14** can be arranged in a staggered pattern. In another embodiment, the secondary hot zone heat pipes **14** are symmetrically located on both edge sides of the heat-conducting chamber body **11** along a longitudinal axis L. Additionally, some of the primary hot zone heat pipes **13** are positioned in the first region while others are outside of the first region and adjacent to the periphery of the first region. According to the two embodiments mentioned above, the number of the primary hot

zone heat pipes **13** can be reduced by 20% and replaced by the secondary hot zone heat pipes **14**.
[0053] The secondary hot zone heat pipes **14** are disposed in the heat-conducting chamber body **11** and communicated to the secondary hot zone S**12** of the first chamber S**1**. In one embodiment, the secondary hot zone heat pipes **14** are positioned in the first region. In other words, the secondary hot zone heat pipes **14** fall within the area right above heat absorption surface **114** in the heat-conducting chamber body **11**. However, the embodiment is not limited thereto. In one embodiment, the secondary hot zone heat pipes **14** are positioned outside of the first region. In other words, the secondary hot zone heat pipes **14** fall outside of the area right above heat absorption surface **114** in the heat-conducting chamber body **11**. In another embodiment, while some of the secondary hot zone heat pipes **14** are positioned in the first region, the rest of the secondary hot zone heat pipes are not. In other words, some of the secondary hot zone heat pipes **14** fall within the area right above heat absorption surface **114** in the heat-conducting chamber body **11**, while the rest do not. For example, two of the secondary hot zone heat pipes **14** are positioned outside the first region and each replaces a primary hot zone heat pipe **13** adjacent to the first region, and the rest of the secondary hot zone heat pipes **14** are positioned within the first region. The secondary hot zone heat pipes **14** can further dissipate the heat from the heat source. Additionally, in one embodiment, the number of the primary hot zone heat pipes **13** located on the side adjacent to the air inlet side edge **115** along the longitudinal axis L of the heat-conducting chamber body **11** is, for example, greater than or equal to 10% of the total number of the primary hot zone heat pipes **13** and the secondary hot zone heat pipes **14** combined together.
[0054] One side of the heat-conducting chamber body **11** is close to a heat dissipation device (not shown) such as a fan. Specifically, the heat-conducting chamber body **11** has an air inlet edge **115**. The air inlet side edge **115** is adjacent to the fan and has a high heat dissipation efficiency. Some of primary hot zone heat pipes **13** are located on a side of the heat-conducting chamber body **11** along a longitudinal axis L, adjacent to the air inlet side edge **115**. Accordingly, the cooling fluid in the primary hot zone S**11** is heated and vaporized into a gaseous state, and the vaporized cooling fluid flows from the primary hot zone S**11** through the second chamber S**2** to the primary hot zone heat pipes **13**. The cooling airflow generated by the heat dissipation device, such as a fun, flows from the air inlet edge **115** across the primary hot zone pipes **13**, thereby dissipating heat from the gaseous cooling fluid in the primary hot zone heat pipes **13**.
[0055] In one embodiment, the distance from the air inlet edge **115** to the nearest primary hot zone heat pipe is, for example, less than or equal to one-third of the length of the longitudinal axis L of the heat-conducting chamber body **11**. For example, if the length of the longitudinal axis L is 150 millimeters, the distance from the air inlet edge **115** to the nearest primary hot zone heat pipe could be 49.5 millimeters.
[0056] In one embodiment, when the power of the heat source is low, the primary hot zone S**11** and the secondary hot zone S**12** are sufficient to dissipate heat from the heat source. When the power of the heat source is high, the cooling fluid in the second chamber S**2** flows into the center of the primary hot zone S**11** of the first chamber S**1** that is in fluid communication with the second chamber S**2**, and the first chamber S**1** and the second chamber S**2** work together to dissipate heat from the heat source. Accordingly, it can avoid functional degradation of the high heat cooling device **10** caused by partially dry burning and maintain the heat dissipation performance of the high heat cooling device **10**, making the high heat cooling device **10** more efficient. The cooling device **10** is designed to effectively manage heat from systems that include multiple heating chips or local hot spot in one chip.
[0057] Specifically, when the power of the primary heat source corresponding to the primary hot zone S**11** is greater than or equal to 70% of the total power of the heat source, the primary hot zone S**11** can supply a larger power load to increase the heat dissipation efficiency of the heat source because the cooling fluid filling amount of the primary hot zone S**11** is greater than that of the secondary hot zone S**12**. When the power of the primary heat source corresponding to the primary

hot zone S**11** is less than 70% of the total power of the heat source, the cooling fluid filling rate through the primary hot zone S**11** remains greater than or equal to 60% of the volume of the capillary pore and the cooling fluid filling amount would be less than or equal to the 80% of the volume of the first chamber S**1**. Accordingly, a mechanism of coexistence of boiling and evaporation can be formed by overfilling the primary hot zone S**11** with cooling fluid, thereby preventing the primary hot zone S**11** from being partially dry burning due to excessively high temperature of the heat source. Additionally, the cooling fluid filling rate in the secondary hot zone is at least 50% of the volume of the capillary pore and does not exceed 130% of the volume of the capillary pore.
[0058] In one embodiment, the high heat cooling device **10** may include a plurality of supporting pillars **16**. The supporting pillars **16** protrude from the first heat-conducting casing **111** and the partition plate **113** respectively. The supporting pillars **16** disposed on the first-conducting casing **111** protrude toward the partition plate **113** and at least a portion of the supporting pillars abut against the partition plate **113**, and at least a portion of the supporting pillars **16** disposed on the partition plate **114** protrude toward the second heat-conducting casing **112** and abut against the second heat-conducting casing **113**. Accordingly, the high heat cooling device **10** can be prevented from expanding or deforming after being heated due to the support of the supporting pillars.
[0059] In one embodiment, the high heat cooling device **10** may further include a plurality of heat dissipation fins (not shown). The heat dissipation fins disposed on the primary hot zone heat pipes **13** and the secondary hot zone heat pipes **14** to further improve the heat dissipation efficiency of the high heat cooling device **10**.
[0060] In one embodiment, there is one partition plate **113**, so the heat-conducting chamber body **11** is divided into two chambers S**1** and S**2** by the partition plate **113**, but the embodiment is not limited thereto. In another embodiment, the number of partition plates may be more than two, so the heat-conducting chamber body can be divided into multiple chambers by the partition plates.
[0061] In one embodiment, the primary hot zone S**11** is communicated with the second chamber S**2**, but the embodiment is not limited thereto. In another embodiment, the primary hot zone S**11** can also be communicated to the first chamber S**1**.
[0062] In the embodiment, the primary hot zone S**11** and the secondary hot zone S**12** are respectively filled with different types of cooling fluid, but the embodiment is not limited thereto. In another embodiment, the primary hot zone S**11** and the secondary hot zone S**12** may also be filled with the same type of cooling fluid.
[0063] In one embodiment, the filling rate of the cooling fluid in the primary hot zone S**11** is greater than the filling rate of the cooling fluid in the secondary hot zone S**12**, but the embodiment is not limited thereto. In another embodiment, the filling rate of the cooling fluid in the primary hot zone may only need to be different from the filling rate of the cooling fluid in the secondary hot zone.
[0064] In one embodiment, there are a plurality of primary hot zone heat pipes **13** and a plurality of secondary hot zone heat pipes **14**, but the embodiment is not limited thereto. In another embodiment, the number of the primary hot zone heat pipes and the secondary hot zone heat pipes may respectively only be one each.
[0065] In one embodiment, the capillary structures **15** are disposed on both the first chamber S**1** and the second chamber S**2**, but the embodiment is not limited thereto. In another embodiment, for example, the first chamber can be a thermosiphon chamber, and the capillary structures are only disposed on the secondary hot zone of the first chamber so that, following the gaseous cooling fluid in the second chamber condenses into a liquid state, the cooling fluid in liquid state can return to the primary hot zone S**11** via gravity.
[0066] Referring to FIG. **8**. FIG. **8** is a schematic cross-sectional view of two cooling fluids flowing in the first chamber and the second chamber respectively in the high heat cooling device of FIG. **1**. In one embodiment, the first heat-conducting casing **111** of the high heat cooling device **10**

is thermally coupled to the heat source H**1** through the heat-absorbing surface **114**. When the heat from the heat source H**1** is transferred to the primary heat zone S**11** through the heat-absorbing surface **114**, the cooling fluid in the primary hot zone S**11** absorbs the heat and vaporizes into a gaseous state, and the vaporized cooling fluid flows through the opening **1131** along the direction A to the second chamber S**2**. Subsequently, the vaporized cooling fluid flows in the second chamber S**2** along the direction B, and then flows from the second chamber S**2** along the direction C to the primary hot zone heat pipe **13**. Further, when the heat from the heat source H**1** is transferred to the secondary hot zone S**12** through the heat-absorbing surface **114**, the cooling fluid in the secondary hot zone S**12** absorbs the heat and vaporizes into a gaseous state, and the vaporized cooling fluid flows from the first chamber S**1** to the secondary hot zone heat pipe **14** along the direction D and the secondary hot zone S**12** along the direction E.

[0067] When the vaporized cooling fluid is cooled and condensed into a liquid state in the primary hot zone heat pipe **13**, it flows in the opposite direction of C from the primary hot zone heat pipe **13** to the second chamber S**2**, flows in the opposite direction of B through the second chamber S**2** to the opening **1131**, and then flows in the opposite direction of A though the opening **1131** to the primary hot zone S**11** to complete the cooling cycle of the primary hot zone S**11**, the second chamber S**2** and the primary hot zone heat pipe **13**. Further, when the vaporized cooling fluid is cooled and condensed into a liquid state in the secondary hot zone heat pipe **14**, it flows from the secondary hot zone heat pipe **14** in the opposite direction of D to the first chamber S**1** and in the opposite direction of E to the secondary hot zone S**12** to complete the cooling cycle of the secondary hot zone S**12** and the secondary hot zone heat pipe **14**.

[0068] In one embodiment, there is a single isolation ring **12** and a single opening **1131**, but the embodiment is not limited thereto. In another embodiment, there may be multiple isolation rings and the partition plate may have multiple openings, referring to FIGS. **9-11**. FIG. **9** is an exploded schematic diagram of a high heat cooling device according to one embodiment of the present disclosure. FIG. **10** is a partially enlarged three-dimensional schematic view of the high heat cooling device of FIG. **9**. FIG. **11** is a partially enlarged exploded view of the high heat cooling device of FIG. **9**.

[0069] The high heat cooling device **10**A of this embodiment is similar to the high heat cooling device **10**, so the differences will be described below, and the similarities will not be repeated. In one embodiment, the high heat cooling device **10**A includes a plurality of isolation rings **12**A, and the partition plate **113**A has a plurality of openings **1131**A. At least one of the plurality of isolation rings **12**A is, for example, cylindrical. The isolation rings **12**A divide the first chamber S**1**A into a plurality of primary hot zones S**11**A, and a secondary zone S**12**A that is not communicated with the plurality of primary hot zones S**11**A. The primary hot zones S**11**A are communicated to the second chamber S**2** respectively via the corresponding openings **1131**A.

[0070] Referring to FIGS. **12-14**. FIG. **12** is a schematic plan view of the heat-conducting chamber body of the high heat cooling device of FIG. **9**. FIG. **13** is a schematic plan view of the high heat cooling device of FIG. **9**. FIG. **14** is a schematic cross-sectional view of a high heat cooling device along line **14-14** of FIG. **13**.

[0071] In one embodiment, when the heat from the heat source H**1** is transferred to the primary hot zones S**11**A through the heat-absorbing surface **114**, the cooling fluid located in the primary hot zones S**11**A absorbs the heat and vaporizes into a gaseous state, and the vaporized cooling fluid passes through the openings **1131**A in the direction F and flows to the second chamber S**2**. Subsequently, the vaporized cooling fluid flows in the second chamber S**2** along the direction G, and then flows from the second chamber S**2** along the direction H to the primary hot zone heat pipe **13**. Further, when the heat from the heat source H**1** is transferred to the secondary hot zone S**12**A through the heat-absorbing surface **114**, the cooling fluid in the secondary hot zone S**12**A absorbs the heat and vaporizes into a gaseous state, and the vaporized cooling fluid flows from the first chamber S**1**A to the secondary hot zone heat pipe **14** along the direction I and to the secondary hot zone S**12**A along the direction J.

[0072] When the vaporized cooling fluid is cooled and condensed into a liquid state in the primary hot zone heat pipe **13**, it flows from the primary hot zone heat pipe **13** to the second chamber S**2** in the opposite direction of H. Subsequently, the liquid state working fluid flows in the second chamber S**2** in the opposite direction of G, and then flows in the opposite direction of F though the opening **1131**A to the primary hot zone S**11**A to complete the cooling cycle of the primary hot zone S**11**A, the second chamber S**2** and the primary hot zone heat pipes **13**. Further, when the vaporized cooling fluid is cooled and condensed into a liquid state in the secondary hot zone heat pipes **14**, it flows from the secondary hot zone heat pipe **14** in the opposite direction of I to the first chamber S**1**A and in the opposite direction of J to the secondary hot zone S**12** to complete the cooling cycle of the secondary hot zone S**12**A and the secondary hot zone heat pipes **14**.

[0073] In one embodiment, when the power of the heat source is low, the primary hot zone and the secondary hot zone separated by the isolation ring are sufficient to dissipate heat from the heat source. When the power of the heat source is high, the cooling fluid in the second chamber flows into the center of the primary hot zone of the first chamber that is in fluid communication with the second chamber, and the first chamber and the second chamber work together to dissipate heat from the heat source. Accordingly, it could avoid functional degradation of the high heat cooling device caused by partially dry burning and maintain the heat dissipation performance of the high heat cooling device, making the high heat cooling device more efficient. The cooling device may be suitable for heat sources such as higher power wafers.

[0074] Specifically, when the power of the primary heat source corresponding to the primary hot zone is greater than or equal to 70% of the total power of the heat source, the primary hot zone can supply a larger power load to increase the heat dissipation efficiency of the heat source because the cooling fluid filling amount of the primary hot zone is greater than that of the secondary hot zone. When the power of the primary heat source corresponding to the primary hot zone is less than 70% of the total power of the heat source, the cooling fluid filling rate through the primary hot zone remains greater than or equal to 60% of the volume of the capillary pore, and the cooling fluid filling amount would be less than or equal to the 80% of the volume of the first chamber. Accordingly, a mechanism of coexistence of boiling and evaporation can be formed by overfilling the primary hot zone with cooling fluid, thereby preventing the primary hot zone from being partially dry burning due to excessively high temperature of the heat source.

[0075] Further, when the external temperature of the high heat cooling device is lower than the freezing point of the cooling fluid in the secondary hot zone S**12**, the cooling fluid in the secondary hot zone S**12** changes to solid state, and the cooling fluid in the primary hot zone S**11** can still maintain its liquid state and flow normally. Accordingly, the cooling fluid located in the primary hot zone S**11** can heat the solidified cooling fluid in the secondary hot zone S**12** so that the cooling fluid in the secondary hot zone S**12** could melt into a liquid state and resume normal flow.

[0076] In other embodiments, based on the specific design of the fins, the high cooling device may have varying heat exchange efficiencies across different regions. Some areas within the device can be highly effective at transferring heat, while others may be less efficiency. According to the present disclosure, the primary hot zone heat pipes can be strategically positioned in the region with high efficiency of heat exchange. By optimizing the placement of the primary hot zone heat pipes, the device can capitalize on the areas with enhanced thermal conductivity, thereby maximizing the overall efficiency of heat transfer. This approach ensures that the device operates optimally by concentrating heat dissipation efforts where they are most effective, leading to improved performance and reliability of the cooling system.

[0077] Therefore, embodiments disclosed herein are well adapted to attain the ends and advantages mentioned as well as those that are inherent therein. The particular embodiments disclosed above are illustrative only, as the embodiments disclosed may be modified and practiced in different but equivalent manners apparent to those of ordinary skill in the relevant art having the benefit of the teachings herein. Furthermore, no limitations are intended to the details of construction or design herein shown, other than as described in the claims below. It is therefore evident that the particular illustrative embodiments disclosed above may be altered, combined, or modified and all such variations are considered within the scope and spirit of the present disclosure. Of course, the disclosed embodiments are merely exemplary embodiments and that various modifications can be made without departing from the spirit and scope of the disclosure. Further, it should be understood that various aspects of the embodiment are not mutually exclusive of each other and can be combined as desired by a person of ordinary skill in the art as a matter of design choices.

[0078] The embodiments illustratively disclosed herein suitably may be practiced in the absence of any element that is not specifically disclosed herein and/or any optional element disclosed herein. While compositions and methods are described in terms of "comprising," "containing," or "including" various components or steps, the compositions and methods can also "consist essentially of" or "consist of" the various components and steps. All numbers and ranges disclosed above may vary by some number. Whenever a numerical range with a lower limit and an upper limit is disclosed, any number and any included range falling within the range is specifically disclosed. In particular, every range of values (of the form, "from about a to about b," or, equivalently, "from approximately a to b," or, equivalently, "from approximately a-b") disclosed herein is to be understood to set forth every number and range encompassed within the broader range of values. Also, the terms in the claims have their plain, ordinary meaning unless otherwise explicitly and clearly defined by the patentee. Moreover, the indefinite articles "a" or "an," as used in the claims, are defined herein to mean one or more than one of the elements that it introduces.

Claims

1. A high heat cooling device, comprising: a heat-conducting chamber body having a heat-absorbing surface, a first chamber and a second chamber, the first chamber being arranged closer to the heat-absorbing surface than the second chamber; and at least one isolation ring disposed in the first chamber of the heat-conducting chamber body that divides the first chamber into a primary hot zone and a secondary hot zone, wherein: the primary hot zone is not in communication with the secondary hot zone, and the primary hot zone is surrounded by the isolation ring and is in communication with the second chamber.

2. The high heat cooling device according to claim 1, wherein the primary hot zone and the secondary hot zone are filled with different types of cooling fluid.

3. The high heat cooling device according to claim 2, wherein the freezing point of the cooling fluid in the primary hot zone is lower than that of the cooling fluid in the secondary hot zone.

4. The high heat cooling device according to claim 1, wherein a cooling fluid filling rate in the primary hot zone is different from that in the secondary hot zone.

5. The high heat cooling device according to claim 4, wherein the cooling fluid filling rate in the primary hot zone is greater than that in the secondary hot zone.

6. The high heat cooling device according to claim 1, wherein the area of the primary hot zone is equal to or greater than 5% of the heat source area, and less than or equal to 80% of the heat source area.

7. The high heat cooling device according to claim 4, wherein the cooling fluid filling rate in the primary hot zone is equal or greater than 60% of the volume of the capillary pore, and the cooling fluid filling rate in the secondary hot zone is at least 50% of the volume of the capillary pore and does not exceed 130% of the volume of the capillary pore.

8. The high heat cooling device according to claim 1, further comprises a plurality of primary hot zone heat pipes, wherein the plurality of primary hot zone heat pipes are disposed in the heat-conducting chamber body and are in fluid communication with the second chamber and the primary hot zone of the first chamber.

9. The high heat cooling device according to claim 8, wherein at least one primary hot zone heat pipes is positioned outside of the first region that is an area right above the heat-absorbing surface in the heat-conducting chamber body.
10. The high heat cooling device according to claim 1, further comprises a plurality of secondary hot zone heat pipes, wherein the secondary hot zone heat pipes are disposed in the heat-conducting chamber body and communicated to the secondary hot zone of the first chamber.
11. The high heat cooling device according to claim 10, wherein the secondary hot zone heat pipes are configured to be positioned entirely within the first region, entirely outside of the first region, or in a configuration where some secondary hot zone heat pipes are within in the first region while others are positioned outside of the first region.
12. The high heat cooling device according to claim 8, wherein at least one primary hot zone heat pipe is located on a side of the heat-conducting chamber body along a longitudinal axis.
13. The high heat cooling device according to claim 12, wherein the heat-conducting chamber body includes an air inlet side edge, and the distance from the air inlet edge to the nearest primary hot zone heat pipe is less than or equal to one-third of the length of the longitudinal axis of the heat-conducting chamber body.
14. The high heat cooling device according to claim 13, wherein a portion of the plurality of primary hot zone heat pipes are located adjacent to the air inlet side edge.
15. The high heat cooling device according to claim 1, further comprises a plurality of primary hot zone heat pipes, wherein at least one primary hot zone heat pipe is in fluid communication with the primary hot zone, and the number of the primary hot zone heat pipes located on the side adjacent to the air inlet side edge along the longitudinal axis of the heat-conducting chamber body is greater than or equal to 10% of the total number of the primary hot zone heat pipes and the hot zone heat pipes combined together.
16. The high heat cooling device according to claim 1, further comprising: a first heat-conducting casing; a second heat-conducting casing; and at least one partition plate having at least one opening, wherein: the partition plate is arranged between the first-heat conducting casing and the second heat-conducting casing, the first chamber and the second chamber are formed by coupling the first heat-conducting casing, the second heat-conducting casing and the partition plate, and the first chamber and the second chamber are located on opposite sides of the partition plate, the heat-absorbing surface is located on a side of the first heat-conducting casing and is further away from the second heat-conducting casing, the isolation ring having a first end and a second end connect to the first heat-conducting casing and the partition plate, respectively, and the primary hot zone is communicated to the second chamber via at least one opening.
17. The high heat cooling device according to claim 16, wherein the thickness of the partition plate is equal to or greater than 0.1 mm and less than or equal to 5 mm.
18. The high heat cooling device according to claim 1, wherein a capillary structure is disposed in both the first chamber and the second chamber.
19. The high heat cooling device according to claim 1, wherein a capillary structure is only disposed on the secondary hot zone of the first chamber.