

IMMERSION COOLING APPARATUS

BACKGROUND

[0001] As electronic systems become more compact, there is a continuing desire to increase the rate of heat transfer away from heat-dissipating components. Air or water-cooled heat sinks can be affixed to the heat-dissipating component to help cool the heat-dissipating component. Often, a thermal interface material is used at the interface between the heat sink and the heat-dissipating component. The thermal resistance of the thermal interface material can contribute significantly to the overall thermal resistance between the heat-dissipating component and the environment.

[0002] Immersion cooling, in which the heat-dissipating component is immersed directly in a heat transfer fluid, provides certain advantages in cooling heat-dissipating components. Immersion cooling, for example, allows the thermal interface material to be eliminated.

[0003] Although liquid immersion heat transfer techniques have been used in larger scale electronic systems, the use of liquid immersion heat transfer techniques in small electronic devices, such as, for example, personal computers has been limited. Immersion cooling systems typically require complex hardware and complicated sealing and degassing operations to assemble. There is a continuing need to provide inexpensive immersion cooling components that can be easily installed in a manufacturing process or by an end-user.

SUMMARY

[0004] The present invention relates generally to a device for cooling electronic components, and more particularly, to a device for immersing an electronic component in a cooling fluid. In one aspect, the present invention provides an inexpensive device for immersing a heat-dissipating component. The device can be installed easily in a manufacturing process or by an end-user.

[0005] In one aspect, the present invention provides a device for cooling a heat-dissipating component comprising a body comprising at least one sidewall and a breachable seal cooperating to define an enclosed volume. The breachable seal has an inner surface proximate the enclosed volume and an outer surface. A quantity of heat transfer fluid is disposed within the enclosed volume. In some embodiments, the article comprises a means for breaching the seal such that the heat transfer fluid is allowed to contact the heat-dissipating component.

[0006] In some embodiments, the heat transfer fluid comprises at least one of a perfluorocarbon, hydrofluorocarbon, hydrofluoroether, and perfluoroketone. In certain embodiments, the breachable seal comprises at least one of a polymer film, a metal foil, and a multilayer barrier film. The breachable seal can have a burst strength that is less than the sidewall. In some embodiments, the sidewall comprises at least one of a polymer film, a metal foil, and a multilayer barrier film.

[0007] In some embodiments, a puncturing member comprising a striking surface is used to breach the breachable seal. The striking surface can be positioned within the enclosed volume. In some embodiments, the striking surface is positioned proximate the outer surface of the breachable seal.

[0008] In some embodiments, the breachable seal is affixed to the sidewall. In other embodiments, the breachable seal is removable.

[0009] In some embodiments, a reactive metal is positioned within the enclosed volume to scavenge oxygen. In certain embodiments, an adsorbent is positioned within the enclosed volume.

[0010] An attachment interface or other attachment means can be used to affix the body to a substrate or a heat-dissipating device. Some embodiments also include a boiling enhancement and a thermal interface material.

[0011] In some embodiments, the device is used as a thermosyphon, as part of a larger cooling system, or as a component in a computer.

[0012] The present invention also provides an article for cooling a heat-dissipating component comprising a body having at least one sidewall, an enclosed volume, an expansion volume, a quantity of heat transfer fluid disposed within the enclosed volume, and means for releasing the heat transfer fluid from the enclosed volume to the expansion

volume. Upon release into the expansion volume, the heat transfer fluid can contact the heat-dissipating device.

[0013] The present invention also provides methods for installing an article for cooling a heat-dissipating component. The method includes affixing a body to a substrate supporting a heat-dissipating component. The body comprising at least one sidewall and a breachable seal cooperating to define an enclosed volume, and a quantity of heat transfer fluid disposed within the enclosed volume. After affixing the body, the seal is breached to allow the heat transfer fluid to contact the heat-dissipating component.

[0014] The term “breachable seal” refers to a material that can be broken, ruptured, torn, or removed through an application of manual force without damaging adjacent components. The manual force may be applied to an instrument, such as, for example, a puncturing member or pull tab, to break, rupture, tear, or remove the seal.

BRIEF DESCRIPTION OF THE DRAWING

[0015] FIG. 1 is a perspective view of an exemplary embodiment of the present invention positioned on a substrate;

[0016] FIG. 2 is a cross-sectional view along sectional lines A-A of the exemplary embodiment shown in FIG. 1 prior to placement on the substrate and breaching of the seal;

[0017] FIG. 3 is a cross-sectional view along sectional lines A-A of the exemplary embodiment shown in FIG. 1 after placement on the substrate and breaching of the seal;

[0018] FIG. 4 is a cross-sectional view of an exemplary embodiment of the present invention having a puncturing member within a spacing member;

[0019] FIG. 5 is a cross-sectional view of an exemplary embodiment of the present invention having a puncturing member within the enclosed volume;

[0020] FIG. 6A is a cross-sectional view of an exemplary embodiment of the present invention having a tether within the enclosed volume and a spring member to attach a boiling enhancement;

[0021] FIG. 6B is a cross-sectional view of the exemplary embodiment shown in FIG. 6A after attachment to a substrate and breaching of the seal;

[0022] FIG. 7A is a cross-sectional view of an exemplary embodiment of the present invention having a flexible sidewall; and

[0023] FIG. 7B is a cross-sectional view of the exemplary embodiment shown in FIG. 7A after attachment to a substrate and breaching of the seal.

[0024] These figures, which are idealized, are not to scale and are intended to be merely illustrative of the present invention and non-limiting.

DETAILED DESCRIPTION

[0025] FIG. 1 shows a perspective view of an exemplary embodiment of the present invention positioned on a substrate. As shown in FIG. 1, a body 10 is affixed to a substrate 12. The body 10 has an internal volume that contains a heat transfer fluid that is in contact with a heat-dissipating component (not shown) affixed to the substrate 12. In some embodiments, the body 10 is affixed directly to the heat-dissipating component.

[0026] In some embodiments, fluid conduits 13 can be connected to body 10 such that the heat transfer fluid within body 10 is in fluid communication with other cooling components, such as, for example, a condenser or heat exchanger. The conduits 13 can be tubular as shown in FIG. 1. Alternatively, the conduits can be any shape or configuration known to those skilled in the art, including, for example, square, rectangular, or oval.

[0027] In other embodiments, the heat transfer fluid within body 10 is not in fluid connection with external cooling components. In such embodiments, body 10 can act as a thermosyphon by having a first region that functions as an evaporator and a second region that functions as a condenser. In such an embodiment, the body can have an expandable sidewall such that the pressure within the body remains substantially constant during operation.

[0028] FIG. 2 is a cross-sectional view along sectional lines A-A of the exemplary embodiment shown in FIG. 1 prior to placement on the substrate and breaching of the seal. As shown in FIG. 2, the body 10 has a sidewall 14 and a breachable seal 18. The sidewall 10 and breachable seal 14 cooperate to define an enclosed volume 28 and an expansion volume 29. A quantity of heat transfer fluid 16 is disposed within the enclosed volume 28.

[0029] Also shown in FIG. 2 is attachment interface 20. The attachment interface 20 can be used to affix the body 10 to a substrate. The attachment interface 20 can also be used to form a seal between the body 10 and the substrate to prevent fluid leakage. The attachment interface 20 can be an adhesive tape, sealant, glue, elastomeric gasket, O-ring,

or any other material known by those skilled in the art to create an effective seal for retaining fluids.

[0030] Alternatively, the body 10 can be affixed directly to the substrate or heat-dissipating device without an attachment interface 20. For example, welding or using a mechanical clamp can affix the body 10 directly to the substrate. In some embodiments, a mechanical fastener is used to affix the body 10 to the substrate.

[0031] FIG. 3 is a cross-sectional view along sectional lines A-A of the exemplary embodiment shown in FIG. 1 after placement on a substrate 12 and breaching of the seal. As shown in FIG. 3, the heat transfer fluid 16 is contained within the enclosed volume 28 and expansion volume. The heat transfer fluid 16 contacts a boiling enhancement 22 affixed to a heat-dissipating component 26. A thermal interface material 24 is positioned between the boiling enhancement 22 and the heat-dissipating component 26. In alternate embodiments, the boiling enhancement 22 and thermal interface material 24 are not present.

[0032] The sidewall 14 can be rigid, flexible, or a combination of rigid and flexible materials. Materials suitable for use as a sidewall include, for example, metal, glass, ceramic, plastic, polymeric films, and multilayer barrier films such as those commonly used in food packaging, particularly those lined with a polyamide or polyimide.

[0033] The term multilayer barrier film refers to any combination of metal, plastic, or cellulosic layers (e.g., foils, films, and paper). The combination of metal, plastic, or cellulosic layers can include multiple layers of different materials, such as, for example, a metal combined with a plastic layer. The combination of metal, plastic, or cellulosic layers can also include multiple layers of similar materials, such as, for example, two layers of plastic.

[0034] Multilayer barrier films useful in the present invention include multilayer films with layers that are affixed to one another, for example, by coating, laminating, coextrusion, or deposition. Multilayer barrier films useful in the present invention can comprise layers of low-density polyethylene, high-density polyethylene, polypropylene, polyester, nylon, polyethylene-co-vinyl acetate, polyvinylidene chloride, polyamide, or polyimide. In some embodiments, a multilayer barrier composite having a layer of metal, such as, for example, aluminum is used. Multilayer barrier films and other films useful for

the sidewall of the present invention are described in U.S. Pat. Nos. 4,997,032 (Danielson et al.) and 5,411,077 (Tousignant), incorporated by reference.

[0035] In certain embodiments, the sidewall is made from at least one of stamped metal, machined metal, and plastics such as, for example, polycarbonate, nylon, acrylic, acrylonitrile butadiene styrene ("ABS"), phenolics, polyolefin, polyurethanes, polyphenylene sulfide, and polyarylether ketones such as polyetheretherketone ("PEEK").

[0036] In some embodiments, the sidewall selected is a dielectric to protect adjacent electronics. In certain embodiments, the sidewall material is selected, at least in part, based on the thermal gradient across the material. In some embodiments, the sidewall material is selected, at least in part, based on the air permeability of the material. In certain embodiments, at least a portion of the sidewall is substantially transparent such that it is possible to visually inspect the enclosed volume. A substantially transparent sidewall can also be used to enhance the visual appearance of the body. In some embodiments, the sidewall material is a non-flammable material.

[0037] In some embodiments, the sidewall is flexible such that the internal pressure of the body can be kept substantially constant as the heat flux from the heat-dissipating device varies. In other embodiments, the sidewall is rigid and the internal pressure does not remain constant over the operating temperature range of the heat-dissipating device. In yet further embodiments, the sidewall is rigid and the internal pressure of the body can be kept substantially constant as the heat flux from the heat-dissipating device varies by attaching a flexible member to the body 10 via conduit 13.

[0038] Materials that can be punctured, ruptured, torn, or easily removed can be used for the breachable seal including, for example, polymer film, a metal foil, or a multilayer barrier film. In certain embodiments, the breachable seal is made from a material that has low gas permeability. In some embodiments, the burst strength of the material used for breachable seal is less than the burst strength of the material used for the sidewall.

[0039] In some embodiments, the body is packaged in a sealed multilayer barrier film. The multilayer barrier film allows the body to be packaged in an environment with a minimum amount of undesirable gases. In some embodiments, the multilayer barrier film is filled with an inert gas or substantially evacuated prior to sealing the body in the package. By packaging the body in a substantially inert environment, a breachable seal with a higher gas permeability can be used without allowing a substantial amount of

unwanted gases to enter the enclosed volume of the body. In such an embodiment, the breachable seal can be made from a thin polymer film that can be easily breached.

[0040] The heat transfer fluid useful in the present invention can be any fluid capable of transferring heat, including water, air, volatile fluids, such as, for example, alcohols, and electronic cooling fluids known to those skilled in the art. In certain embodiments, the heat transfer fluid is dielectric, non-flammable, and provides a significant vapor pressure at the operating temperature of the heat-dissipating component.

[0041] In certain embodiments, the heat transfer fluid is thermally conductive, chemically inert, essentially gas-free, and thermally stable. In other embodiments, the heat transfer fluid has a boiling point that is at or below the operating temperature of the heat-dissipating component such that portions of the liquid adjacent the heat-dissipating component will vaporize when conducting heat. The heat transfer fluid can be selected from the representative class of fluorinated linear, branched or cyclic alkanes, ethers, ketones, tertiary amines, and aminoethers, and mixtures thereof. In some embodiments, perfluorinated fluids are used in this invention, though partially fluorinated fluids can also be used. The perfluorinated fluids can be straight chain, branched chain, cyclic, or a combination thereof. In some embodiments, the perfluorinated fluids can be saturated, that is, free of ethylenic, acetylenic, and aromatic unsaturation. The skeletal chain can include catenary oxygen and/or trivalent nitrogen heteroatoms providing stable links between fluorocarbon groups and not interfering with the inert character of the compound. In some embodiments, hydrofluoroethers, either segregated or non-segregated are used. In other embodiments, perfluorinated ketones are used.

[0042] Representative examples of suitable fluorinated fluids or mixtures thereof useful for the present invention are commercially available from 3M Company, St. Paul, Minnesota, and marketed under various trade designations, including, for example, "3M BRAND FLUORINERT ELECTRONIC LIQUIDS" and "3M BRAND NOVEC ENGINEERED FLUIDS", described in 3M Company product bulletin No. 98-0212-2249-7, issued January 2003. Other commercially available fluorochemicals useful in the present invention are those available from Solvay Solexis S.p.A, Bollate, Italy, under the trade designation "GALDEN PFPE: HEAT TRANSFER FLUIDS" and their hydrofluoroethers available under the trade designation "H-GALDEN ZT HEAT TRANSFER FLUID". Heat transfer fluids useful in the present invention also include

hydrofluorocarbon compounds such as those sold under the trade designations “VERTREL SPECIALTY FLUIDS” and “SUVA REFRIGERANTS” available from DuPont, Wilmington, Delaware.

[0043] Illustrative examples of suitable boiling enhancements include, for example, carbon foam, a heat spreader such as, for example, a flat plate, pin fin array, an array of channels, or other three-dimensional structures made of thermally conductive metal or composite material that increases surface area for boiling. These enhancements may be further enhanced by the application of a microporous coating, modulated microreplicated features, or capillary structures that enhance boiling heat transfer by aiding nucleation or impeding the hydrodynamic mechanisms that lead to surface dry out. In another embodiment, the boiling enhancement is a coating applied to the heat-dissipating component 26 and no thermal interface material 24 is present.

[0044] The thermal interface material 24 can be solder or any conventional thermal compound commonly known in the art. In certain embodiments, the thermal interface material is a low melting point eutectic alloy, such as, for example, a eutectic alloy based upon indium that will remain liquid at the operating temperature of the thermal interface material. Such materials are desirable from a performance standpoint but are normally subject to oxidation when exposed to air in their molten state. The closed environment created by the present invention can be used to control the exposure level of thermal interface materials to oxygen such that the level of oxidation is minimized.

[0045] The heat dissipating component 26 can be a semiconductor, such as, for example, a central or graphics processing unit, an insulated gate bipolar transistor (IGBT), memory module, or an application specific integrated circuit (ASIC). In other embodiments, the heat dissipating component 24 can be a hard disk drive, power supply, transformer, laser diode array, light emitting diode (LED) array, halogen bulb, or any other heat-dissipating component known to those skilled in the art. The heat dissipating component can also be a non-heat generating structure, such as, for example, an integrated heat spreader (IHS) that is connected to a heat-generating device, such as, for example, a semiconductor.

[0046] FIG. 4 is a cross-sectional view of an exemplary embodiment of the present invention having a puncturing member 430 within an optional spacing member 417. The spacing member 417 can be integrally formed with the sidewall 414 or can be affixed to

the sidewall 414. In some embodiments, the spacing member 414 is made of a different material than the sidewall 414. For example, the spacing member 414 can be made of a more rigid material to facilitate a better seal between the body 410 and a substrate.

Likewise, the sidewall 414 can be made of a more flexible material to facilitate pressure fluctuations within the enclosed volume 428 or to facilitate breaching of the seal 418.

[0047] As shown in FIG. 4, the puncturing member 430 has a striking surface 432. In certain embodiments, the striking surface 432 forms a point. The puncturing member 430 can be positioned so that distal end 433 extends beyond the lower surface 419 of the spacing member 417. During placement of the body 410 onto a substrate, the distal end 433 contacts the substrate and causes the puncturing member 430 to move relative to the seal 418 such that the striking surface 432 contacts and punctures the seal 418 causing the enclosed volume 428 to join the expansion volume 429.

[0048] In some embodiments, the distal end 433 extends beyond the attachment interface 420 such that the distal end 433 is the first element to contact the substrate during attachment of the body 410. In such embodiments, the body 410 may be inverted during attachment to prevent the heat transfer fluid 416 from entering the expansion volume 429 and potentially spilling.

[0049] In other embodiments, the distal end is positioned approximately flush with or below the attachment interface 420. In such embodiments, the attachment interface 420 or spacing member 417 can be made from a compressible material. Compression of either the attachment interface 420 or spacing member 417 by placing a force on the body 410 will cause the puncturing member 430 to move relative to the seal 418 such that the striking surface 432 contacts and punctures the seal 418 causing the enclosed volume 428 to join the expansion volume 429.

[0050] FIG. 5 is a cross-sectional view of an exemplary embodiment of the present invention having a puncturing member 530 within the enclosed volume 528. The puncturing member 530 has a striking surface 532 and a distal end 533. By applying a force to the distal end 533, the striking surface 532 will contact and puncture the seal 518 causing the enclosed volume 528 to join the expansion volume 529. A puncturing member seal 531 at the sidewall 514 prevents the heat transfer fluid 516 from escaping through the sidewall 514. In another embodiment, the distal end of the puncturing member is affixed to the inner surface of the sidewall and does not extend through or

beyond the sidewall. In such embodiment, a force upon the sidewall causes the sidewall to flex thus moving the puncturing member toward the breachable seal 518 and breaching the seal 518.

[0051] FIG. 6A is a cross-sectional view of an exemplary embodiment of the present invention having a tether within the enclosed volume and a spring member to attach a boiling enhancement. FIG. 6B is a cross-sectional view of the exemplary embodiment shown in FIG. 6A after attachment to a substrate and breaching of the seal. As shown in FIGS. 6A and 6B, a tether 640 can be used to cause the seal 618 to be breached. A first end of the tether 640 is affixed to the breachable seal and the second end of the tether can be affixed to the sidewall 614. As shown in FIG. 6B, the body can be deformed, either temporarily or permanently, causing the tether 60 to breach the seal 618. Alternatively, the tether 640 can extend through the sidewall such that it can be pulled manually outside of the body 610.

[0052] Other techniques for breaching an internal seal known to those skilled in the art can also be employed. For example, in other embodiments, the breachable seal extends through the sidewall and can be breached or removed by manually grasping and pulling a tab connected to the seal from outside of the body. In yet further embodiments, the burst strength of the breachable seal is sufficiently low such that pressure applied to the body causes the pressure in the enclosed volume to increase and rupture the breachable seal.

[0053] Also shown in FIGS. 6A and 6B is an embodiment that uses a retaining clip 642 to affix a boiling enhancement 622 to the body 610. A thermal interface material 624 can be affixed to the boiling enhancement 622. The retaining clip is used to facilitate placement of a boiling enhancement on a heat-dissipating device 626 affixed to a substrate 612. In some embodiments, the retaining clip is made of a resilient but flexible material such that boiling enhancement 622 and thermal interface material 624 can move relative to the body 610. The retaining clips can be made from metal, plastic, or any other material useful for attaching components known to those skilled in the art.

[0054] Body 10 can also contain small amount of reactive metal, 652, such as activated nickel intended to scavenge oxygen that might be inside body 10 at the time of manufacture or that might enter at the time the device is installed. Body 10 can also contain small amount of adsorbent, 650, such as activated carbon or other suitable material intended to scavenge less volatile materials, such as, for example, low molecular weight

polymers, UV stabilizers, or plasticizers that might over time be extracted from the materials in contact with the fluid and be deposited at the boiling surface disrupting performance.

[0055] FIG. 7 is a cross-sectional view of an exemplary embodiment of the present invention having a flexible sidewall. As shown in FIG. 7, the body 710 can have a flexible sidewall 714 affixed to a spacing member 717 using a flange 744. In some embodiments, the flexible sidewall 714 comprises at least two substantially planar sheets of material that are bonded to one another at their periphery to form a seal 715. In such an embodiment, the sidewall 714 can comprise heat-sealable films that can be thermally bonded to one another. In yet further embodiments, the heat-sealable films can be thermally bonded to the flange 744. In other embodiments, the sidewall 714 is affixed to the spacing member 717 using any means known to those skilled in the art, including, for example, adhesive and mechanical fasteners.

[0056] The attachment interface 720 is used to connect the body 710 to a substrate or heat-dissipating component. The enclosed volume 728 and expansion volume 729 are connected by breaching the breachable seal 718 and allowing the heat transfer fluid 716 to flow into the expansion volume 729. The breachable seal 718 can be breached using any of the methods described above. In certain embodiments having a flexible sidewall such as body 710, the breachable seal 718 is ruptured by increasing the pressure in the enclosed volume 728. The pressure can be increased by manually squeezing the flexible sidewall 714 of the body 710.

[0057] FIG. 7B is a cross-sectional view of the exemplary embodiment shown in FIG. 7A after attachment to a substrate and breaching of the seal. As shown in FIG. 7B, the body 710 is affixed to substrate 712 using attachment interface 720. A heat-dissipating component 726, such as, for example, a central processing unit, is affixed to the substrate 712. A boiling enhancement 722, such as, for example, a microporous coating, is applied to the heating dissipating component 726. After the breachable seal 718 is removed or broken, the heat transfer fluid 716 is allowed to enter the expansion volume 729 and contact the boiling enhancement 722.

[0058] It is to be understood that even in the numerous characteristics and advantages of the present invention set forth in above description and examples, together with details of the structure and function of the invention, the disclosure is illustrative only. Changes

can be made to detail, especially in matters of shape, size and arrangement of the breachable seal and sidewall and methods of use within the principles of the invention to the full extent indicated by the meaning of the terms in which the appended claims are expressed and the equivalents of those structures and methods.

WHAT IS CLAIMED IS:

1. An article for cooling a heat-dissipating component comprising:
a body comprising at least one sidewall and a breachable seal cooperating to define an enclosed volume, said breachable seal having an inner surface proximate said enclosed volume and an outer surface; and
a quantity of heat transfer fluid disposed within said enclosed volume.
2. The article of claim 1 wherein said heat transfer fluid comprises at least one of a perfluorocarbon, hydrofluorocarbon, hydrofluoroether, and perfluoroketone.
3. The article of claim 1 wherein said breachable seal comprises at least one of a polymer film, a metal foil, and a multilayer barrier film.
4. The article of claim 3 wherein said breachable seal comprises a burst strength that is less than said sidewall.
5. The article of claim 1 wherein said sidewall comprises at least one of a polymer film, a metal foil, and a multilayer barrier film.
6. The article of claim 5 wherein at least a portion of said sidewall is substantially transparent.
7. The article of claim 1 further comprising at least one puncturing member comprising a striking surface.
8. The article of claim 7 wherein said striking surface is positioned within said enclosed volume.
9. The article of claim 7 wherein said striking surface is positioned proximate said outer surface of said breachable seal.

10. The article of claim 1 wherein said breachable seal is affixed to said sidewall.
11. The article of claim 1 wherein said breachable seal is removable.
12. The article of claim 1 further comprising at least one tether having one end affixed to said seal.
13. The article of claim 1 further comprising a means for breaching said seal.
14. The article of claim 1 further comprising a reactive metal positioned within said enclosed volume.
15. The article of claim 1 further comprising an adsorbent positioned within said enclosed volume.
16. The article of claim 1 further comprising an attachment interface to affix said body to a substrate or heat-dissipating component.
17. The article of claim 1 further comprising an attachment means to affix said body to a substrate or heat-dissipating component.
18. The article of claim 1 further comprising a boiling enhancement comprising at least one of carbon foam and a microporous coating.
19. The article of claim 18 further comprising a thermal interface material affixed to at least a portion of said boiling enhancement.
20. The article of claim 19 wherein said thermal interface material comprises a eutectic alloy.

21. The article of claim 1 further comprising a boiling enhancement affixed to said body by a retaining clip.

22. A thermosyphon comprising an article according to claim 1.

23. A cooling system comprising an article according to claim 1.

24. A computer comprising an article according to claim 1.

25. An article for cooling a heat-dissipating component comprising a body having at least one sidewall, an enclosed volume, an expansion volume, a quantity of heat transfer fluid disposed within said enclosed volume, and means for releasing said heat transfer fluid from said enclosed volume to said expansion volume.

26. The article of claim 25 wherein said heat transfer fluid comprises at least one of a perfluorocarbon, hydrofluorocarbon, hydrofluoroether, and perfluoroketone.

27. The article of claim 25 wherein said sidewall comprises at least one of a polymer film, a metal foil, and a multilayer barrier film.

28. A cooling system comprising an article according to claim 25.

29. A computer comprising an article according to claim 25.

30. A method of installing an article for cooling a heat-dissipating component comprising:

affixing a body to a substrate supporting a heat-dissipating component, said body comprising at least one sidewall and a breachable seal cooperating to define an enclosed volume, and a quantity of heat transfer fluid disposed within said enclosed volume; and

breaching said seal to allow said heat transfer fluid to contact said heat-dissipating component.

31. The method of claim 30 further comprising affixing a boiling enhancement to said heat-dissipating component.

32. The method of claim 31 wherein said boiling enhancement is affixed to said heat-dissipating component with a thermal interface material comprising a eutectic alloy.

33. The method of claim 31 wherein said boiling enhancement is soldered to at least a portion of said heat-dissipating component.

34. The method of claim 30 wherein said heat-dissipating component comprises an integrated circuit.

35. The method of claim 30 further comprising placing a condenser in fluid communication with said body.