

# HEATER FOR SEMICONDUCTOR CHIPS

## FIELD OF THE INVENTION

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The present invention relates to a heater for semiconductor chips, in particular, for heating semiconductor chips prior to integrity test, and an apparatus comprising more than one of the heater.

## 10 BACKGROUND

Semiconductor chips are normally tested over a range of temperatures to verify that the semiconductor chips operate properly across the range of temperatures. The range of temperatures during testing may be from room ambient temperature to  
15 elevated temperatures, or in some cases lower temperature tests. With regard to elevated temperature tests, the semiconductor chips are tested after heating the semiconductor chips.

Conventionally, for elevated temperature tests, the semiconductor chips are placed  
20 on horizontally aligned hot plates (pre-heated). The number of hot plates is normally limited to 3 due to space consideration. Due to the limited number of hot plates, only a certain number of semiconductor chips can be heated at one time. This would subsequently result in longer time to complete the temperature testing process. Furthermore, the hot plates for heating the semiconductor chips are also exposed to  
25 the surrounding environment. Heating the semiconductor chips in such exposed condition leads to heat loss and this affects the consistency in the heating of the semiconductor chips for testing.

## SUMMARY

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According to an example of the present disclosure, there are provided a heater and an apparatus as claimed in the independent claims. Some optional features are defined in the dependent claims.

## 35 BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will be better understood and readily apparent to one skilled in the art from the following written description, by way of example only and in conjunction with the drawings, in which:

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Fig. 1 is a top view of an apparatus according to an example of the present disclosure;

Fig. 2 is a perspective view of the apparatus comprising of two heaters for heating semiconductor chips prior to temperature testing of the semiconductor chips;

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Fig. 3 is an enlarged view of one of the heaters in Fig. 2 showing the detailed interior arrangement of the heater;

Fig. 4 is an enlarged view of two bases that are adjacent to each other in the heater of Fig. 3;

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Fig. 5 is a cross-sectional side view of two bases, wherein one base has semiconductor chips placed thereon and heating elements in each base are revealed.

Fig. 6 illustrates a heating station of the apparatus of Fig. 1.

Fig. 7 illustrates two bases configured to form two respective input slots for placement or removal of the semiconductor chips.

These figures are not drawn to scale and are intended merely for illustrative purposes.

## DETAILED DESCRIPTION

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Fig. 1 illustrates an overview of a process or method of temperature testing of integrated circuit (IC) chips 300 performed by a temperature testing system 100. The temperature testing system 100 may be housed as one apparatus or machine and be thus referred to as one apparatus or machine. In the present example, the IC chips 300 that are to be tested are in a form of an IC strip 302. The IC chips 300 can also be known as semiconductor chips in the present disclosure. Such semiconductor chips may be joined together in a strip with uncut lead frames. Each of the semiconductor chips may be a chip contained in a chip package. When the semiconductor chips are joined together by lead frames and cut into strips, each of these strips would be referred as the IC strip 302 in the present disclosure. In the present disclosure, lead frames may refer to metal structures inside a chip package that carry signals from the die to the outside. It is understood that the temperature testing system 100 comprises one or more controller (e.g. Programmable Logic Controller (PLC)), computer, processor, and the like to control the process or method that is performed.

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There is a plurality of IC chips 300 on one IC strip 302. For example, the IC chips 300 may be arranged evenly in two rows on the IC strip 302 as illustrated in Fig. 3.

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The IC strip 302 that is to undergo temperature testing is first loaded by a loader device 101, which can be a magazine stacker input, into a first buffer area 110 (also known as shuttle input area) where the IC strip 302 is not yet heated. Subsequently, the IC strip 302 is transferred from the first buffer area 110 to a heater 112 by a pick and place device 200.

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The IC strip 302 that is placed in the heater 112 will be heated up to a target temperature. An example of the target temperature could be 130 degrees Celsius. The time taken to reach the target temperature of 130 degrees may be between 10 seconds to 60 seconds, depending on the heating conditions. When the temperature of the IC strip 302 reaches the target temperature, the IC strip 302 will be transferred from the heater 112 to a movable stage 119 of a test station 114 by the pick and place device 200. The heated IC strip 302 has to be moved by the stage 119 to a test platform 106 for the testing. It is appreciated that the temperature testing system 100 is not limited to testing the above stated temperature and may include any temperature testing that is necessary to determine the functionality and reliability (or integrity) of the IC strip 302.

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At the test station 114, various testing may be performed on the heated IC strip 302 to determine the functionality and quality (or integrity) of the IC strip 302. After the testing, the IC strip 302 is transferred from the test platform 106 to a movable stage 121 to be transferred to a cooling station 116 (e.g. a station at ambient temperature) by another pick and place device 202, which picks up the IC strip 302 from the stage 121 to place it in the cooling station 116. After cooling down to a desired temperature, the IC strip 302 is transferred from the cooling station 116 to a second buffer area 118 (also known as shuttle output area 118) of the test station 114 by the pick and place device 202. The tested IC strip 302 will then be unloaded by an unloader device 103, which can be a magazine stacker output, and this completes the process of temperature testing.

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In the present example, there are actually two heaters 112 and 113 and four pick and place devices 200, 201, 202, and 203 in the temperature testing system 100 to run two separate lines to improve productivity. Each line referred herein refers to subjecting each IC strip 302 through the loading, heating, testing, cooling and unloading process of the temperature testing system 100. The two heaters 112 and 113 have the same features. The pick and place device 201 has the same operation as the pick and place device 200 described above, and the pick and place device 203 has the same operation as the pick and place device 202 described above. The pick and place devices 200 and 202 operates separately from the pick and place devices 201 and 203. Stages 115 and 117 in Fig. 1 have the same operation as the stages 119 and 121 respectively.

An example of each of the pick and place devices 200, 201, 202 and 203 may be one or more robotic arms, wherein the movement of the one or more robotic arm is driven by one or more motors.

In the present example, each of the pick and place devices 200, 201, 202 and 203 has a pair of pick and place arms (for example, the arms 105A and 105B of the pick and place device 200 in Fig. 1), which are configured to move in tandem with each other. For example, one arm 105A of the pair of pick and place arms 200 is configured to carry a plurality of unheated semiconductor chips 300 in the form of the IC strip 302 from the first buffer station 110 and place them in the heater 112, and the other arm 105B of the pair of pick and place arms 200 is configured to remove the plurality of heated semiconductor chips 300 in the form of the IC strip 302 from the heater 112 and place them in the stage 119 of the test station 114 for testing the heated semiconductor chips 300. Furthermore, for example, one arm 107A of the pair of pick and place arms 202 is configured to carry a plurality of heated semiconductor chips 300 in the form of the IC strip 302 from the stage 121 and place them in the cooling station 116, and the other arm 107B of the pair of pick and place arms 200 is configured to remove the plurality of cooled semiconductor chips 300 in the form of the IC strip 302 from the cooling station 116 and place them in the second buffer area 118 for unloading.

Fig. 6 shows how the arms 105A and 105B, the pick and place devices 200 and 201 may actually look like in the temperature testing system 100 after deployment. The arm 105A is movable along a rail 604 to reach into and out of the heater 112 to remove heated semiconductor chips 300 and the arm 105B is movable through the rail 604 to reach into and out of the first buffer station 110 to pick up unheated semiconductor chips 300. There is another rail 602 for both arms 105A and 105B to move along in tandem to let the arm 105A holding the heated semiconductor chips 300 transfer them to the test station 114 and to let the arm 105B holding the unheated semiconductor chips 300 to transfer them into the heater 112. The arms 107A and 107B can be configured in the similar manner as the arms 105A and 105B.

Returning to Fig. 1, in the present example, the pick and place devices 200, 201, 202, and 203 pick or place the IC strips 302 by way of vacuum suction. Other picking/placement methods such as by way of mechanical pick up tools that are typically used in the semiconductor industry to pick or place semiconductor chips 300 are also possible.

In the present example, only one test platform 106 is present in the test station 114 for testing heated semiconductor chips 300 provided by two separate testing lines. Hence, the pick and place devices 200 and 201 may be configured to pick up IC strip 302 from input slots of the heaters 112 and 113 at different time to place the IC strip 302 in the test station 114. For instance, the pick and place device 200 may be

configured to first pick up a heated IC strip X from the heater 112 and place it at the stage 119 and the pick and place device 201 is configured to pick up a heated IC strip Y from the heater 113 only after the heated IC strip X is moved to the test platform 106. That is, if the time to place the heated IC strip X in the test station 114 is  $t$ , the time to place the heated IC strip Y would be  $t + z$  seconds, wherein  $z$  can be adjusted for optimal efficiency that can be achieved in this case when there is one test platform 106. It should be noted that such test platform 106 is very costly equipment. Hence, having just one test platform 106 to support two separate lines helps to reduce cost.

Fig. 2 illustrates a perspective view of the heaters 112 and 113 of Fig. 1 for heating a plurality of semiconductor chips 300, which may be in the form of IC strips 302. Each heater 112 and 113 comprises a casing 210 configured to provide an input slot 205 for the pick and place device 200 or 201 to pick or place the plurality of semiconductor chips 300 out of or into the casing 210 respectively. Each heater 112 and 113 also comprises one or more base 220 disposed in the casing 210 for placing the plurality of semiconductor chips 300 thereon for heating. In the case of Fig. 2, there are actually more than one bases 220. Each heater 112 and 113 further comprises one or more heating elements (not shown) disposed in the casing 210 for heating the plurality of semiconductor chips 300. Specifically, the input slot 205 is formed by moving the more than one bases 220 such that whenever a base is required for placement or removal of semiconductor chips, the base is moved in a manner to form the input slot 205 to provide space for the pick and place device 200 or 201 to pick or place semiconductor chips on the base moved to form the input slot 205.

In one example, the heater 112 may only have one base within the casing 210 and the heater 112 in such a configuration will allow the plurality of semiconductor chips 300 to be placed on the base. In the example of Fig. 2, the heaters 112 and 113 each has ten bases 220 within the casing 210, which allows ten sets of plurality of semiconductor chips 300, for instance, ten IC strips 302, to be individually placed on each of the ten bases 220. This advantageously reduces the cycle time for temperature testing since each heater 112 or 113 allows up to ten IC strips 302 to be heated up at the same time.

It is noted that the casing 210 shown in Fig. 2 is an example where one side of the casing 210 is not enclosed and the ten bases 220 are revealed. In other examples, the casing 210 of the heater 112 or 113 may be substantially sealed or covered such that the casing 210 acts as insulation during heating of the IC strip 302 and the input slot 205 is the only area that can be opened to provide for placing the IC strips 302 into one of the bases of the heater 112 or 113. Such configuration can prevent heat loss during the heating process so that good quality of heating can be achieved. The input slot 205 need not be covered and may be left fully opened for the pick and place device 200 or 201 of Fig. 1 to enter or exit to pick or place the plurality of semiconductor chips 300 out of or into each base of the heater 112 or 113. Alternatively, a flap door (not shown in the figures) may be mounted at the input slot 205 to open for the pick and place device 200 or 201 to enter and for the pick and place device 200 or 201 to exit. There can be an example where there is a plurality of input slots 205 located on one side of the casing and each of these input slots 205 may or may not have a flap door.

A scenario illustrating how the cycle time for temperature testing is reduced by using temperature testing system 100 is described below.

#### Example 1

Consider a scenario that an IC strip requires 20 secs to be heated up to 130°C.

Under existing technology, it may be possible to allow 3 IC strips to be soaked inside a thermal chamber. Hence, on average, 1 IC strip would require 6.7 secs to be heated up to 130°C.

In the example of Fig. 1 and 2, the temperature testing system has the following configuration:

Number of heaters: 2

Number of bases in the casing of each heater: 10

Number of IC strips that can be placed on the bases in the casing of each heater: 10

Since there are 2 heaters, the number of IC strips that can be heated up at the same time is 20. Hence, on average, 1 IC strip would only require 1 sec to be heated up to 130°C.

The cycle time for temperature testing is therefore significantly reduced by approximately 5 to 6 times.

In the example of Fig. 2, there are more than one bases 220 disposed in the casing 210, specifically ten bases. The more than one bases 220 may be stacked one on top of the other and the more than one bases 220 may move along a vertical axis orthogonal to surfaces of the more than one bases 220. The more than one bases are movable along the vertical axis 221 such that each base can be moved to form the input slot 205 to enable the pick and place device 200 to pick or place the plurality of semiconductor chips 300 out of or into the casing 210 respectively. The movements of the more than one bases 220 along the vertical axis 221 are shown by the two bidirectional arrows present in Fig. 2. In Fig. 2, the lowest base is forming the input slot 205.

It is noted that there can be a few configurations as follows for the pick and place device 200 or 201 to access the heater 112 or 113 for heating semiconductor chips 300.

Configuration 1: The more than one bases 220 are movable along the vertical axis 221. The position of the input slot 205 is for the pick and place device 200 or 201 to place one IC strip 302 on one base of the heater 112 or 113 and the position of the input slot 205 remains stationary. The pick and place device 200 or 201 is fixed in position in the same plane as the position of the input slot 205 and does not move along the vertical axis 221. The pick and place device 200 or 201 only moves in horizontal direction with respect to the vertical axis 221 for the pick and place actions.

Configuration 2: The position of the input slot 205 is for the pick and place device 200 or 201 to place one IC strip 302 on one base of the heater 112 or 113. The pick and place device 200 or 201 can move horizontally with respect to the vertical axis 221 for the pick and place actions. The pick and place device 200 or 201 are fixed in the same plane as the position of the input slot 205. The pick and place device 200 or 201 and the position of the input slot 205 are movable along the vertical axis 221. However, the more than one bases 220 remain stationary. The input slot 205 is considered as moved or moving when different bases are moved or moving to form the input slot 205 respectively.

The stacking of the more than one bases 220 in a vertical manner not only enables several strips of the plurality of semiconductor chips 300 to be heated up at the same time but also allows the physical width dimensions of the heater 112 or 113 to

remain unaffected despite having a significant increase in the numbers of semiconductor chips 300 to be heated. Only the height dimensions of the heater 112 or 113 would be affected since the heater 112 or 113 is in a form of a tower with a particular height. However, this is still highly beneficial especially when there are  
5 space constraints in a user's premises in which the physical width dimensions of the heater 112 or 113 cannot be extended any further to accommodate for more semiconductor chips 300 to be heated. Such vertical configuration of the heater 112 or 113 advantageously solves the space constraint problem of a user who wishes to increase the efficiency of heating more the semiconductor chips 300.

10 With reference to Fig. 2 and Fig. 3, specifically for the heater 112, each of the more than one bases 220 may be moveable in a manner such that, when each base is moved to form the input slot 205, a distance *B* (or gap) between the moved base 310 and an adjacent base 304 above the moved base 310 is larger than distance *A* (or  
15 gap) between a base 306 not forming the input slot 205 and another adjacent base 305 above the base 306 not forming the input slot 205 so as to provide more space for the pick and place device 200 to reach into the casing 210 to place or remove the plurality of semiconductor chips 300. The distance *A* should be as little as possible such that the base 306 and adjacent base 305 are configured to provide an  
20 enclosure as shown in Fig. 3 to enclose the semiconductor chips placed on the base 306. This enclosure promotes good heating. The distance *B* should be sufficient to accommodate an arm of the pick and place device 200 to reach into the input slot 205.

25 Fig. 4 shows a rear view of the bases 305 and 306 of Fig. 3. A thermocouple 402 for measuring temperature is connected to the rear of each base 305 or 306. Each base 305 or 306 comprises connectors 404 for connecting a heating element (not shown) disposed in each base 305 or 306 to a heating device (not shown) for heating. Each  
30 base 305 and 306 may be slidably connected to one or more sliding bars (not shown) and driving mechanisms (not shown) connected to a motor (not shown) to drive their motion.

In one example, one or more heating elements may be disposed to provide heat above the plurality of semiconductor chips 300 of Fig. 3 to heat the plurality of  
35 semiconductor chips 300 from above. For example, the one or more heating elements may be disposed to heat a base above the plurality of semiconductor chips 300 so as to heat the plurality of semiconductor chips 300 from above. One or more heating elements may also be disposed to heat the one or more base so that the plurality of semiconductor chips 300 placed on the one or more base is heated from  
40 below by the heated one or more base. Specifically, one or more heating elements may be disposed at each base of the more than one bases to heat the plurality of semiconductor chips 300 disposed between every two adjacent bases.

Specifically, in Fig. 3, there are 10 bases in the casing 210 of the heater 112. The 10  
45 bases are numbered from 1 to 10 accordingly in Fig. 3, with the lowest base being number 1 and the highest base being number 10. The 10 bases may move along the vertical axis 221 such that placement or removal of the plurality of semiconductor chips 300 by the pick and place device 200 for heating is performed in an order such that after a first base is subject to placement or removal of the plurality of  
50 semiconductor chips 300, a second base adjacent to the first base is deliberately skipped for placement or removal of semiconductor chips 300 and a third base is selected for placement or removal of more semiconductor chips 300. When it is time for placement or removal, each base forms the input slot 205 to provide space for the pick and place device 200 to reach in for placement or removal, otherwise the  
55 bases are held close together to form enclosures to promote heating.

For example, consider that the first base is numbered as 1, the second base is numbered as 2, the third base is numbered as 3 and so on ..... until the tenth base is numbered as 10. The placement of the semiconductor chips 300 can be in the following sequence base 1, base 3, base 5, base 7, base 9, base 10, base 8, base 6, base 4, base 2, and back to base 1 and so on. By the time the pick and place device 200 is at the second base 2, the semiconductor chips 300 that were initially placed on the first base (i.e. base number 1) at the beginning of the sequence would have been heated up. The heated semiconductor chips 300 that were placed on the first base 1 would then be removed and unheated semiconductor chips 300 may then be placed onto the empty first base 1 for heating. The sequence to place and remove semiconductor chips 300 from each respective base would then continue in the sequence base 3, base 5, base 7, base 9, base 10, base 8, base 6, base 4, and base 2, and back to base 1. Such order or sequence of movement of the more than one bases in Fig. 3 provides an advantage in the sense that at every instance in a process of placement or removal of semiconductor chips 300 to or from a base, only a short distance is required to be moved by the more than one bases to enable placement or removal of more semiconductor chips 300. This improves productivity greatly compared to another possible example of the present disclosure where each base in the more than one bases are moved and subject to placement or removal sequentially until a final base to form the input slot 205 is reached and the more than one bases have to then move back to form the input slot 205 using a first base at an opposite end of the final base for placement or removal. For this example, the placement of the semiconductor chips 300 would be in the following sequence base 1, base 2, base 3, base 4, base 5, base 6, base 7, base 8, base 9, and base 10. Upon reaching base 10, the semiconductor chips 300 that were initially placed on the first base 1 at the beginning of the sequence would have been heated up. The more than one bases would then have to move all the way back to form the input slot 205 using base 1 so that the semiconductor chips 300 that were placed on the first base 1 can be removed. The sequence of placing and removing then continues with the sequence base 2, 3, 4, 5, 6, 7, 8, 9, 10 before going back to base 1 again. This is less efficient as the more than one bases have to move a longer distance from base 10 to base 1 as compared to much shorter distance from base 1 to 3.

Fig. 5 shows a cross-sectional side view along C-C in Fig. 4 of the bases 305 and 306 of Fig. 3.

Fig. 5 shows a heating element 502 disposed within the base 305 to provide heat above a plurality of semiconductor chips 300 placed on the base 306 to heat the plurality of semiconductor chips 300 from above. Fig. 5 also shows a heating element 504 disposed within base 306 to heat the plurality of semiconductor chips 300 placed on base 306 from below. The base 305 may comprise a plurality of ribs 305B and walls 305A, extending towards the adjacent base 306. These ribs 305B and/or walls 305A help to form an enclosure to enclose the plurality of semiconductor chips 300 on the base 306 to promote good heating. The walls 305A extend to contact the base 306. The ribs 305B and/or walls 305A also ensure presence of a gap between the bases 305 and 306 preventing the base 305 from contacting the semiconductor chips 300.

Furthermore, Fig. 5 illustrates that one or more of the more than one bases in Fig. 3 may comprise a plurality of protrusions 500 distributed over a surface under each base for contacting the lead frames 506 of the plurality of semiconductor chips 300 placed on an adjacent base facing the plurality of protrusions 500 to ensure that the plurality of semiconductor chips 300 are uniformly seated with respect to one another on the adjacent base. In Fig. 5, specifically, both bases 305 and 306 have such

protrusions 500 and the protrusions 500 of base 305 are contacting the lead frames 506 of a strip of semiconductor chips 300. Such plurality of protrusions 500 solves a problem relating to warpage of the lead frames 506 of the plurality of semiconductor chips 300 because the protrusions 500 exert pressure on the lead frames 506 to  
5 reduce or remove the warpage and keep the semiconductor chips 300 relatively aligned with respect to one another. This promotes equivalent and uniform heating for every semiconductor chip 300. Specifically, the protrusions 500 are disposed on the ribs 305B and the ribs 305B are present to enable the protrusions 500 to be spaced apart and distributed evenly to exert the pressure on the lead frames 506. All  
10 the other bases in Fig. 3 can be configured in a similar manner as the bases 305 and 306.

Each of the plurality of protrusions 500 may be a spring plunger. The spring plunger may be a spring loaded device with one end for joining to the base and another end  
15 with a spring retractable ball bearing 508 for contacting the lead frames 506 of the semiconductor chip 300.

Fig. 7 shows a heater 700 according to an example of the present disclosure. The heater 700 comprises a plurality of bases 720 and is configured such that two input slots 702 and 704 are formed by its bases 720 for a pick and place device to place or  
20 remove semiconductor chips placed thereon. Fig. 7 showcases the possibility of an example of the present disclosure where there can be more than one input slots formed for the process or method to heat semiconductor chips. Such configuration can further improve productivity.

25 Examples of the present disclosure may comprise the following features.

A heater for semiconductor chips, the heater comprising:  
30 a casing configured to provide an input slot for a pick and place device to pick or place a plurality of semiconductor chips out of or into the casing respectively;  
one or more base disposed in the casing for placing the plurality of semiconductor chips thereon for heating; and  
one or more heating elements disposed in the casing for heating the plurality of semiconductor chips.

35 Each semiconductor chip may include an IC chip as described with reference to Fig. 1 above.

40 The casing may be configured to be substantially sealed or configured to cover the one or more base to reduce heat loss in the casing.

In a case where there are more than one bases disposed in the casing, the more than one bases may be stacked one on top of the other and the more than one bases may be configured to move along a vertical axis orthogonal to surfaces of the  
45 more than one bases that are configured for the plurality of semiconductor chips to be placed thereon, wherein the more than one bases may be configured to move along the vertical axis such that the input slot may be formable by each base to enable the pick and place device to pick or place the plurality of semiconductor chips out of or into the casing respectively.

50 The one or more heating elements may be disposed to provide heat above the plurality of semiconductor chips to heat the plurality of semiconductor chips from above, and the one or more heating element may be disposed to heat the one or more base so that the plurality of semiconductor chips placed on the one or more  
55 base is heated from below by the heated one or more base.

Each of the more than one bases may be configured such that each base is moveable to form the input slot and a distance between the moved base and an adjacent base above the moved base is larger than a distance between a base not forming the input slot and another adjacent base above the base not forming the input slot so as to provide more space for the pick and place device to reach into the casing through the input slot to place or remove the plurality of semiconductor chips.

Each base of the more than one bases may comprise the one or more heating elements to heat the plurality of semiconductor chips disposed between every two adjacent bases.

The distance between the base not forming the input slot and another adjacent base above the base not forming the input slot may be lesser than a distance between the distance between the moved base and an adjacent base above the moved base so as to reduce space between the base not forming the input slot and the adjacent base above the base not forming the input slot to better heat the plurality of semiconductor chips on the base not forming the input slot. An enclosure for containing heat surrounds the plurality of semiconductor chips on the base not forming the input slot as a result of such reduce space.

The more than one bases may be configured to move along the vertical axis such that placement or removal of the plurality of semiconductor chips by the pick and place device is performed in an order such that after a first base is subject to placement or removal of the plurality of semiconductor chips, a second base adjacent to the first base is deliberately skipped for placement or removal of semiconductor chips and a third base is selected for placement or removal of more semiconductor chips. Such order or sequence of movement of the more than one bases provides an advantage in the sense that at every instance in a process of placement or removal of semiconductor chips to or from a base, only a short distance is required to be moved by the more than one bases to enable placement or removal of more semiconductor chips. This improves productivity greatly compared to an example where each base in the more than one bases are moved and subject to placement or removal sequentially until a final base to form the input slot is reached and the more than one bases have to then move back to form the input slot using a first base at an opposite end of the final base for placement or removal of semiconductor chips at the first base.

The pick and place device may be configured to have a pair of pick and place arms configured to move in tandem with each other, wherein one arm of the pair of pick and place arms is configured to carry a plurality of unheated semiconductor chips from a station and place them in the one or more base, and the other arm of the pair of pick and place arms is configured to remove a plurality of heated semiconductor chips from the one or more base and place them in another station for testing the heated semiconductor chips.

One or more of the more than one bases may comprise a plurality of protrusions distributed over a surface under each base for contacting lead frames of the plurality of semiconductor chips placed on an adjacent base facing the plurality of protrusions to ensure that the plurality of semiconductor chips are uniformly seated with respect to one another on the adjacent base. Such plurality of protrusions solves a problem relating to warpage of the lead frames of the plurality of semiconductor chips.

Each of the plurality of protrusions may be a spring plunger. The spring plunger may be a spring loaded device with one end for joining to the base and another end with

a spring retractable ball bearing for contacting the lead frame of the semiconductor chip.

5 The one or more of the more than one bases may extend to form a rib facing the adjacent base and the plurality of protrusions are disposed on the rib.

Each base of the more than one bases may comprise walls for contacting an adjacent base to form an enclosure for heating the plurality of semiconductor chips placed on the adjacent base.

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An apparatus comprising more than one of the heater for semiconductor chips, wherein the apparatus comprises more than one of the pick and place device to pick and place the plurality of semiconductor chips out of or into the casings of the more than one heaters, wherein the more than one pick and place devices are configured to pick the plurality of semiconductor chips from the input slots of the more than one heaters at different time to place in a test station comprising one test platform used for testing heated semiconductor chips picked by the more than one pick and place devices from the input slots of the more than one heaters.

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In the specification and claims, unless the context clearly indicates otherwise, the term "comprising" has the non-exclusive meaning of the word, in the sense of "including at least" rather than the exclusive meaning in the sense of "consisting only of". The same applies with corresponding grammatical changes to other forms of the word such as "comprise", "comprises" and so on.

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While the invention has been described in the present disclosure in connection with a number of embodiments and implementations, the invention is not so limited but covers various obvious modifications and equivalent arrangements, which fall within the purview of the appended claims. Although features of the invention are expressed in certain combinations among the claims, it is contemplated that these features can be arranged in any combination and order.

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## CLAIMS

1. A heater for semiconductor chips, the heater comprising:  
a casing configured to provide an input slot for a pick and place device to pick or  
place a plurality of semiconductor chips out of or into the casing respectively;  
one or more base disposed in the casing for placing the plurality of semiconductor  
chips thereon for heating; and  
one or more heating element disposed in the casing for heating the plurality of  
semiconductor chips.
2. The heater of claim 1, wherein the casing is configured to be substantially  
sealed or configured to cover the one or more base to reduce heat loss in the casing.
3. The heater of claim 1 or 2, wherein the one or more heating element is  
disposed to provide heat above the plurality of semiconductor chips to heat the  
plurality of semiconductor chips from above, and the one or more heating element is  
disposed to heat the one or more base so that the plurality of semiconductor chips  
placed on the one or more base is heated from below by the heated one or more  
base.
4. The heater of any one of the preceding claims, wherein there are more than  
one bases disposed in the casing, the more than one bases are stacked one on top  
of the other and the more than one bases are configured to move along a vertical  
axis orthogonal to surfaces of the more than one bases that are configured for the  
plurality of semiconductor chips to be placed thereon, wherein the more than one  
bases are configured to move along the vertical axis such that the input slot is  
formable by each base to enable the pick and place device to pick or place the  
plurality of semiconductor chips out of or into the casing respectively.
5. The heater of claim 4, wherein each of the more than one bases is configured  
such that each base is moveable to form the input slot and a distance between the  
moved base and an adjacent base above the moved base is larger than a distance  
between a base not forming the input slot and another adjacent base above the base  
not forming the input slot so as to provide more space for the pick and place device  
to reach into the casing through the input slot to place or remove the plurality of  
semiconductor chips.
6. The heater of claim 3, 4 or 5, wherein each base of the more than one bases  
comprises the one or more heating elements to heat the plurality of semiconductor  
chips disposed between every two adjacent bases.
7. The heater of any one of claims 4 to 6, wherein the more than one bases is  
configured to move along the vertical axis such that placement or removal of the  
plurality of semiconductor chips by the pick and place device is performed in an  
order such that after a first base is subject to placement or removal of the plurality of  
semiconductor chips, a second base adjacent to the first base is deliberately skipped  
for placement or removal of semiconductor chips and a third base is selected for  
placement or removal of more semiconductor chips.
8. The heater of any one of claims 4 to 7, wherein one or more of the more than  
one bases comprises a plurality of protrusions distributed over a surface under each  
base for contacting lead frames of the plurality of semiconductor chips placed on an  
adjacent base facing the plurality of protrusions to ensure that the plurality of  
semiconductor chips are uniformly seated with respect to one another on the  
adjacent base.

9. The heater of claim 8, wherein the one or more of the more than one bases extends to form a rib facing the adjacent base and the plurality of protrusions are disposed on the rib.
- 5 10. The heater of claim 8 or 9, wherein each of the plurality of protrusions may be a spring plunger.
- 10 11. The heater of any one of claims 4 to 10, wherein each base of the more than one bases comprises walls for contacting an adjacent base to form an enclosure for heating the plurality of semiconductor chips placed on the adjacent base.
- 15 12. The heater of any one of the preceding claims, wherein the pick and place device is configured to have a pair of pick and place arms configured to move in tandem with each other, wherein one arm of the pair of pick and place arms is configured to carry a plurality of unheated semiconductor chips from a station and place them in the one or more base, and the other arm of the pair of pick and place arms is configured to remove a plurality of heated semiconductor chips from the one or more base and place them in another station for testing the heated semiconductor chips.
- 20 13. An apparatus comprising more than one of the heater of any one of claims 1 to 12, wherein the apparatus comprises:  
more than one of the pick and place device to pick and place the plurality of  
25 semiconductor chips out of or into the casings of the more than one heaters,  
wherein the more than one pick and place devices are configured to pick the plurality of semiconductor chips from the input slots of the more than one heaters at different time to place in a test station comprising one test platform used for testing heated semiconductor chips picked by the more than one pick and place devices  
30 from the input slots of the more than one heaters.