

A SYSTEM AND METHOD FOR TESTING SILICON CARBIDE (SiC) SEMICONDUCTOR DEVICES

1. TECHNICAL FIELD OF THE INVENTION

The present invention provides a method of testing silicon carbide (SiC) semiconductor device configured to perform parallel testing, which provides faster testing throughput. The method involves utilizing a primary rotary transfer mechanism and at least one secondary rotary transfer mechanism, whereby one primary rotary transfer mechanism may transfer semiconductor devices to a single or a plurality of secondary rotary transfer mechanisms. Once the semiconductor devices are transferred from said primary rotary transfer mechanism to said secondary rotary transfer mechanism, said secondary rotary transfer mechanism is then configured to transfer said semiconductor devices to at least one pre-test station, at least one test station and at least one post-test station to perform the necessary electrical conductivity and functionality test on said semiconductor devices. The present invention also provides the system for performing said testing on said SiC semiconductor devices.

2. BACKGROUND OF THE INVENTION

Conventional known good device (KGD) silicon carbide (SiC) test handler uses linear-based testing arrangement which has slower speed if compared to rotary-based testing arrangement (typical done using primary rotary transfer mechanism) because pre-test alignment, testing, post-test inspection and device handover processes are

doing in series in the linear-based testing arrangement of the prior art. Some of these machines of the prior art sacrifice pre-test alignment and post-test inspection to increase speed and subsequently degrades machine reliability and test performance.

CAMILLETTI ROBERT CHARLES et al, US5693565A, disclosed a
5 semiconductor integrated circuit (IC) die made with enhanced resilience to handling, testing and storage associated with its qualification and distribution as a known good die (KGD). Although the prior art comprises of a step of testing the chip by electrically stressing the chip at an elevated temperature and voltage for time sufficient to cause failure of marginal chips, the prior does not disclose performing parallel testing using
10 primary rotary transfer mechanism and secondary rotary transfer mechanisms to be claimed by the present invention.

Hence, it would be advantageous to alleviate the shortcomings by having a system and method for testing silicon carbide (SiC) semiconductor devices that are configured to perform parallel testing to achieve faster testing throughput.
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3. SUMMARY OF THE INVENTION

Accordingly, it is the primary aim of the present invention to provide a system and method for testing silicon carbide (SiC) semiconductor devices that provides faster speed due to the capability of performing parallel testing, thus testing faster
20 than the conventional linear-based test system.

It is yet another objective of the present invention to provide a system and method for testing silicon carbide (SiC) semiconductor devices which provides for

easier set up of said system as the system comprises of separate secondary rotary transfer mechanisms for each particular test capability, which in turn is makes it easy to add or remove a test capability from said system.

It is yet another objective of the present invention to provide a system and
5 method for testing silicon carbide (SiC) semiconductor devices which provides full vision guided alignment (FVGA) which ensures full inspection and alignment of semiconductor device with the socket pin before and after performing testing.

It is yet another objective of the present invention to provide a system and method for testing silicon carbide (SiC) semiconductor devices which increases
10 productivity as the heating of the semiconductor device is done when the semiconductor device is at the semiconductor device holder at the secondary rotary transfer mechanism, prior to said semiconductor device reaching the test station.

Additional objects of the invention will become apparent with an understanding of the following detailed description of the invention or upon
15 employment of the invention in actual practice.

According to the preferred embodiment of the present invention the following is provided:

A method of testing silicon carbide (SiC) semiconductor device, comprising the steps of:

(i) transferring a semiconductor device from a primary rotary transfer mechanism to a transfer station of a secondary rotary transfer mechanism;

(ii) performing testing on said semiconductor device in at least one test station at said secondary rotary transfer mechanism;

wherein said semiconductor device is rotary-indexed using said secondary rotary transfer mechanism to said test station;

wherein said step (ii) is repeated for at least one subsequent semiconductor device;

wherein said test station is configured to perform electrical connectivity test, electrical functionality test, or combination thereof on said semiconductor device.

In another embodiment of the invention there is provided:

A system of testing silicon carbide (SiC) semiconductor device, comprising of:

at least one tester configured to perform electrical connectivity test and functionality test on said semiconductor device;

characterized in that

said system further comprises of

an indexable primary rotary transfer mechanism;

at least one indexable secondary rotary transfer mechanism configured to receive and transfer said semiconductor device from and to said primary rotary transfer mechanism at a transfer station; said secondary rotary transfer mechanism is configured to rotatably transfer said semiconductor device to at least one test station;

at least one semiconductor device holder at said primary rotary transfer mechanism, secondary rotary transfer mechanism or combination thereof;

wherein said at least one test station comprises of said tester configured to perform electrical connectivity test, electrical functionality test, or combination thereof on said semiconductor device;

wherein said electrical connectivity test and functionality test are done in the presence of any suitable non-flammable gas.

4. BRIEF DESCRIPTION OF THE DRAWINGS

Other aspect of the present invention and their advantages will be discerned after studying the Detailed Description in conjunction with the accompanying drawings in which:

Fig. 1 is a top view of an embodiment of the system of the present invention with two secondary rotary transfer mechanisms.

Fig. 2A to Fig. 2D are top views of the system of the present invention implementing the method of the present invention.

5 Fig. 3 is a closed up front view of an example of the system of the present invention at the transfer station to inspect the contact surface of the second semiconductor device holder at the first secondary rotary transfer mechanism; wherein said contact surface of said semiconductor device holder is configured to be in contact with said semiconductor device.

10 Fig. 4 shows a closed up front view of an example of the system of the present invention at the transfer station showing the semiconductor device being transferred to the second semiconductor device holder of the first secondary rotary transfer mechanism by a first semiconductor device holder at the primary rotary transfer mechanism.

15 Fig. 5 is a closed up front view of an example of the system of the present invention at at least one of the pre-test station to obtain the X-Y coordinate and orientation along X-Y plane of semiconductor device at the semiconductor device holder.

20 Fig. 6A is a closed up front view of an example of the system of the present invention showing how a close-loop electricity connection is obtained when the alignment between the bump of the semiconductor device and the test socket pin of the test socket is obtained; while Fig. 6B is a closed up front view of an example

of the system of the present invention showing how an open-loop electricity connection is obtained when the bump of the semiconductor device is not aligned with the test socket pin of the test socket.

Fig. 7 is a closed up front view of an example of the system of the present invention at the at least one test station whereby the third image capturing device
5 captures at least one third image of a test socket and its test socket pin.

Fig. 8 is a closed up front view of an example of the system of the present invention at the at least one test station whereby the electrical connectivity test and functionality test are performed.

Fig. 9 is a closed up front view of an example of the system of the present invention at the at least one post-test station whereby vision inspection is
10 performed on the semiconductor device to detect defects.

Fig. 10 is a closed up front view of a second example of the system of the present invention at the transfer station to inspect the contact surface of the second semiconductor device holder at the first secondary rotary transfer mechanism;
15 wherein said contact surface of said semiconductor device holder is configured to be in contact with said semiconductor device.

Fig. 11 shows a closed up front view of the second example of the system of the present invention at the transfer station showing the semiconductor device being
20 transferred to the second semiconductor device holder of the first secondary rotary transfer mechanism by a first semiconductor device holder at the primary rotary transfer mechanism.

Fig. 12 is a closed up front view of the second example of the system of the present invention at at least one of the pre-test station to obtain the X-Y coordinate and orientation along X-Y plane of semiconductor device at the semiconductor device holder.

5 Fig. 13A is a closed up front view of the second example of the system of the present invention showing how a close-loop electricity connection is obtained when the alignment between the bump of the semiconductor device and the test socket pin of the test socket is obtained; while Fig. 13B is a closed up front view of the second example of the system of the present invention showing how an open-
10 loop electricity connection is obtained when the bump of the semiconductor device is not aligned with the test socket pin of the test socket.

Fig. 14 is a closed up front view of the second example of the system of the present invention at the at least one test station whereby the third image capturing device captures at least one third image of a test socket and its test socket pin.

15 Fig. 15 is a closed up front view of the second example of the system of the present invention at the at least one test station whereby the electrical connectivity test and functionality test are performed.

Fig. 16 is a closed up front view of the second example of the system of the present invention at the at least one post-test station whereby vision inspection is
20 performed on the semiconductor device to detect defects.

Fig. 17 is a flow chart of the method of testing silicon carbide (SiC) semiconductor device of the present invention.

5. DETAILED DESCRIPTION OF THE DRAWINGS

In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the invention. However, it will be understood by the person having ordinary skill in the art that the invention may be practised without these specific details. In other instances, well known methods, procedures and/or components have not been described in detail so as not to obscure the invention.

The invention will be more clearly understood from the following description of the embodiments thereof, given by way of example only with reference to the accompanying drawings, which are not drawn to scale.

The present invention is a method of testing silicon carbide (SiC) semiconductor device 103, comprising the following steps. In step (i), a semiconductor device 103 is transferred from a primary rotary transfer mechanism 105 to a transfer station 201 at a secondary rotary transfer mechanism, as shown in Fig. 2A. In step (ii), testing is performed on said semiconductor device 103 in at least one test station 205 at said secondary rotary transfer mechanism. Step (ii) is repeated for at least one subsequent semiconductor device 103. The semiconductor device 103 is rotary-indexed using said secondary rotary transfer mechanism to said test station 205.

The test station 205 is configured to perform electrical connectivity test, electrical functionality test, or combination thereof on said semiconductor device 103.

The test station 205 performs the same or different electrical connectivity test, electrical functionality test or combination thereof.

Optionally, the testing in step (ii) can be done while another tested semiconductor device 103 is transferred from said transfer station 201 to said primary rotary transfer mechanism 105, subsequent untested semiconductor device 103 is transferred from said primary rotary transfer mechanism 105 to said transfer station 201 at said secondary rotary transfer mechanism or combination thereof. This is to ensure that the stations at the secondary rotary transfer mechanism are fully utilized to ensure optimized throughput.

The method of testing silicon carbide (SiC) semiconductor device may optionally comprise of the step of performing pre-test on said semiconductor device 103 in at least one pre-test station 203 at said secondary rotary transfer before performing said testing of said semiconductor device 103 in said at least one test station 205 in step (ii); wherein said pre-test station 203 is configured to align said semiconductor device 103 at at least one semiconductor device holder at said secondary rotary transfer mechanism.

The method of testing silicon carbide (SiC) semiconductor device may also optionally comprise of the step of performing post-test on said semiconductor device 103 in at least one post-test station 207 at said secondary rotary transfer after performing said testing of said semiconductor device 103 in said at least one test station 205 in step (ii); wherein said post-test station 207 is configured to detect defect on the surface, inside or combination thereof of said semiconductor device 103.

The method of testing silicon carbide (SiC) semiconductor device may further comprise of the step of performing pre-test and post-test on said semiconductor device 103. Said pre-test on said semiconductor device 103 is done in at least one pre-test station 203 at said secondary rotary transfer before performing said testing of said semiconductor device 103 in said at least one test station 205 in step (ii); wherein said pre-test station 203 is configured to align said semiconductor device 103 on at least one semiconductor device holder on said secondary rotary transfer mechanism. Said post-test is performed on said semiconductor device 103 in at least one post-test station 207 at said secondary rotary transfer after performing said testing of said semiconductor device 103 in said at least one test station 205 in step (ii); wherein said post-test station 207 is configured to detect defect on the surface, inside or combination thereof of said semiconductor device 103.

Steps (i) to (ii), pre-testing steps, post-testing steps or combination thereof can be repeated on at least one more secondary rotary transfer mechanism to perform similar or different test on said semiconductor device 103. This can be shown in Fig. 1, having two secondary rotary transfer mechanisms 104A, 104B, each secondary rotary transfer mechanism having their own test station which may perform similar or different test on said semiconductor device 103. The method of testing silicon carbide (SiC) semiconductor device further comprises of the step of transferring said semiconductor device 103 which fails said test done at said test station 205 to at least one first reject station 125A.

An example of said method of the present invention is shown in Fig. 2A, Fig. 2B, Fig. 2C and Fig. 2D, which shows the sequence of events in performing transfer, pretest, test and post-test using at least one of the secondary rotary transfer mechanisms. In Fig. 2A, a first semiconductor device 103A is transferred from the primary rotary transfer mechanism 105 to the secondary rotary transfer mechanism at the transfer station 201. As shown in Fig. 2B, the first semiconductor device 103A is then rotary transferred by said secondary rotary transfer mechanism to the pre-test station 203 while a second semiconductor device 103B is transferred from the primary rotary transfer mechanism 105 to said secondary rotary transfer mechanism at the transfer station 201. As shown in Fig. 2C, the first semiconductor device 103A is then rotary transferred by said secondary rotary transfer mechanism to the test station 205 while said second semiconductor device 103B is rotary transferred by said secondary rotary transfer mechanism to the pre-test station 203 while said third semiconductor device 103C is transferred from the primary rotary transfer mechanism 105 to said secondary rotary transfer mechanism at the transfer station 201. As shown in Fig. 2D, the first semiconductor device 103A is then rotary transferred by said secondary rotary transfer mechanism to the post-test station 207 while said second semiconductor device 103B is rotary transferred by said secondary rotary transfer mechanism to the test station 205 while said third semiconductor device 103C is rotary transferred by said secondary rotary transfer mechanism to the pre-test station 203 while said fourth semiconductor device 103D is transferred from the primary rotary transfer mechanism 105 to said secondary rotary transfer mechanism at the transfer station 201. The sequence actions depicted in Fig. 2A to Fig. 2D may be repeated for

the subsequent semiconductor devices. The sequence actions depicted in Fig. 2A to Fig. 2D may also be done by another secondary rotary transfer mechanism in said system 101 of the present invention.

Step (i) of the method of testing silicon carbide (SiC) semiconductor device
5 comprises of the following sub-steps. In step (i)(a), as shown in Fig. 3, at least one first image of contact surface 108 of at least one semiconductor device holder at said secondary rotary transfer mechanism is captured when said semiconductor device holder is in said transfer station 201; wherein said contact surface 108 of said semiconductor device holder is configured to be in contact with said semiconductor
10 device; wherein said first image is captured using at least one first image capturing device 111A. In step (i)(b), said first image is analysed to detect foreign material at said semiconductor device holder. If foreign material is detected, said contact surface 108 of said semiconductor device holder configured to be in contact with said semiconductor device will be cleaned using a cleaning mechanism. Said cleaning can
15 be done at the transfer station 201 or another location. In step (i)(c), as shown in Fig. 4, said semiconductor device 103 is transferred from said primary rotary transfer mechanism 105 to said semiconductor device holder at said secondary rotary transfer mechanism when said semiconductor device holder is in said transfer station 201; wherein electrical contact points 110 such as bumps, pads or input/output (I/O)
20 terminals of said semiconductor device 103 when said semiconductor device 103 is at said semiconductor device holder faces away from said semiconductor device holder.

The method of the present invention further optionally comprises of the step of heating said semiconductor device 103 using at least one heating element before step (ii). Preferably, the heating should be done at the transfer station 201. However, it is possible to perform the heating of the semiconductor device 103 at any location of the secondary rotary transfer mechanism so long as the temperature of the semiconductor device is sufficient to be performed the intended test at the test station 205. The main advantage of heating said semiconductor device prior to said semiconductor device 103 reaching the test station 205 is so that the semiconductor device already reaches the intended temperature when reaching said test station 205, without incurring further delay.

The at least one pre-test station 203 comprises of the following sub-steps. In sub-step (a) at the pre-test station, at least one second image of said semiconductor device 103 at said semiconductor device holder at said secondary rotary transfer mechanism is captured when said semiconductor device holder is at said at least one pre-test station 203 using at least one second image capturing device 111B, as shown in Fig. 5. In sub-step (b) at the pre-test station, said second image is analysed to obtain X-Y coordinate and orientation along X-Y plane of said semiconductor device 103. In step (c) at the pre-test station, said X-Y coordinate and orientation along X-Y plane of said semiconductor device 103 are corrected to a predetermined X-Y coordinate and orientation along X-Y plane if said X-Y coordinate and orientation along X-Y plane is not within the predetermined range of the intended X-Y coordinate and orientation along X-Y plane. The correction can be done using a pick-up arm 113 which is configured to pick-up said semiconductor device 103 before changing the X-Y

coordinate and orientation along X-Y plane before attaching said semiconductor device 103 back onto said semiconductor device holder. Sub-steps (a) to (c) are repeated until said X-Y coordinate and orientation along X-Y plane are within a predetermined acceptable range of the intended X-Y coordinate and orientation along X-Y plane. Fig. 6A is a closed up front view of an example of the system of the present invention showing how a close-loop electricity connection 127A is obtained when the alignment between the bump of the semiconductor device and the test socket pin of the test socket is obtained; while Fig. 6B is a closed up front view of the system of the present invention showing how an open-loop electricity connection 127B is obtained when the bump of the semiconductor device is not aligned with the test socket pin of the test socket.

The at least one test station 205 comprises of the following sub-steps. In sub-step (a) at the test station 205, at least one third image of at least one test socket 115 and its at least one test socket pin 117 is captured; using at least one third image capturing device 111C, as shown in Fig. 7; wherein said test socket 115 is attached to a tester 119. In sub-step (b) at the test station 205, said third image is analysed to obtain position of said at least one test socket pin 117 with respect to the crosshair of said third image capturing device 111C. Here, the third image capturing device 111C is at a fixed position. Optionally, said third image is also analysed to detect at least one abnormal physical property of said at least one test socket pin 117 wherein said abnormal physical property may be burnt test socket pin 117 or presence of foreign material on said test socket pin 117. In sub-step (c) at the test station 205, said test socket pins 117 on test socket 115 are aligned to be at the same Z-axis as said

semiconductor device 103 and said test socket pins 117 at the same X-Y coordinate as said semiconductor device's 103 corresponding electrical contact points 110 on said semiconductor device 103 using at least one X-Y axis actuator 121. The alignment can be based on the X-Y deviation in sub-step (a) at the test station and semiconductor device's X-Y deviation. In sub-step (d) at the test station 205, said semiconductor device holder with said semiconductor device 103 is transferred from said secondary rotary transfer mechanism towards said test socket 115 so that said electrical contact points 110 on said semiconductor device 103 is in contact with their corresponding test socket pins 117, as shown in Fig. 8. In sub-step (e) at the test station 205, any suitable non-flammable gas such as nitrogen gas is inserted into a chamber 123 attached to said test socket 115; wherein said chamber 123 encloses said test socket pins 117 and said semiconductor device 103 when said electrical contact points 110 of said semiconductor device 103 is in contact with their corresponding test socket pins 117. In sub-step (f), electrical connectivity test and functionality test are performed on said semiconductor device 103 by said tester 119. In sub-step (g), said any suitable non-flammable gas is released from said chamber 123. In sub-step (h), said semiconductor device holder with said semiconductor device 103 is transferred to said secondary rotary transfer mechanism.

The at least one post-test station 205 comprises of the following sub-steps. In sub-step (i) at the post-test station 205, at least one fourth image of said semiconductor device 103 at said semiconductor device holder at said secondary rotary transfer mechanism is captured when said semiconductor device holder is at said at least one post-test station 207 using at least fourth image capturing device 111D, as shown in

Fig. 9. In sub-step (ii) at the post-test station 205, said fourth image is analysed to detect at least one defect on the surface, inside or combination thereof of said semiconductor device 103. Optionally, said semiconductor device 103 may be transferred from said secondary rotary transfer mechanism to at least one second reject station 125B if at least one defect above acceptable tolerance is detected on the surface, inside or combination thereof of said semiconductor device 103, after step (b) of said at least one post-test station 207. The method of testing silicon carbide (SiC) semiconductor device 103 of the present invention is shown in Fig. 10.

The present invention is also a system of testing silicon carbide (SiC) semiconductor device 103, comprising of at least one tester 119 configured to perform electrical connectivity test and functionality test on said semiconductor device 103. The system further comprises of an indexable primary rotary transfer mechanism 105. The system further comprises of at least one indexable secondary rotary transfer mechanism configured to receive and transfer said semiconductor device 103 from and to said primary rotary transfer mechanism 105 at a transfer station 201; said secondary rotary transfer mechanism is configured to rotatably transfer said semiconductor device 105 to at least one test station 205. Fig. 1 shows an example of the system of the present invention, having a first rotary transfer mechanism 105, a first secondary rotary transfer mechanism 104A and a second secondary rotary transfer mechanism 104B. The system further comprises of at least one semiconductor device holder at said primary rotary transfer mechanism 105, secondary rotary transfer mechanism or combination thereof. The semiconductor device holder comprises of vacuum mechanism, conductive material, heating element or

combination thereof. The test station 205 comprises of said tester 119 configured to perform electrical connectivity test, electrical functionality test, or combination thereof on said semiconductor device 103; wherein said electrical connectivity test and functionality test are done in the presence of any suitable non-flammable gas.

5 In another embodiment, the at least one indexable secondary rotary transfer mechanism may comprise of at least one pre-test station 203 and at least one test station 205; wherein said at least one pre-test station 203 is configured to align said semiconductor device 103 at at least one semiconductor device holder at said secondary rotary transfer mechanism.

10 In another embodiment, the at least one indexable secondary rotary transfer mechanism may comprise of at least one test station 205 and at least one post-test station 207; wherein said at least one post-test station 207 is configured to detect defect on the surface, inside or combination thereof of said semiconductor device 103.

 In another embodiment, the at least one indexable secondary rotary transfer
15 mechanism may comprise of at least one pre-test station 203, at least one test station 205 and at least one post-test station 207.

 The transfer station 201 comprises of at least one first image capturing device 111A configured to capture at least one first image of contact surface 108 of said semiconductor device holder at said secondary rotary transfer mechanism when said
20 semiconductor device holder is in said transfer station 201; wherein said contact surface 108 of said semiconductor device holder is configured to be in contact with

said semiconductor device; wherein said first image capturing device 111A is configured to transfer captured first image to at least one data processing means for image analysis to detect foreign material on said semiconductor device holder.

5 The at least one pre-test station 203 comprises of at least one second image capturing device 111B and at least one pick-up arm 113. The at least one second image capturing device 111B is configured to capture at least one second image of said semiconductor device 103 on said semiconductor device holder at said secondary rotary transfer mechanism when said semiconductor device holder is at said at least one pre-test station 203; said second image capturing device 111B is configured to transfer
10 captured second image to at least one data processing means for image analysis to determine X-Y coordinate and orientation along X-Y plane of said semiconductor device 103. The at least one pick-up arm 113 configured to pick-up said semiconductor device 103 to change the X-Y coordinate and orientation along X-Y plane before attaching said semiconductor back onto said semiconductor device holder.

15 The at least one test station 205 comprises of at least one third image capturing device 111C, at least one X-Y axis actuator 121 and a chamber 123. The at least one third image capturing device 111C configured to capture at least one third image of at least one test socket 115 and its at least one test socket pin 117; said third image capturing device 111C is configured to transfer captured third image to at least one
20 data processing means for image analysis to obtain position of said at least one test socket pin 117 with respect to the crosshair of said third image capturing device 111C; wherein said test socket 115 is attached to said tester 119. The at least one X-Y axis

actuator 121 configured to align said test socket pins 117 on test socket 115 to be at the same Z-axis as said semiconductor device 103 and said test socket pins 117 at the same X-Y coordinate as said semiconductor device's 103 corresponding electrical contact points 110. The chamber 123 attached to said test socket 115 and enclosing said test socket pins 117 and said semiconductor device 103 when said electrical contact points 110 of said semiconductor device 103 is in contact with their corresponding test socket pins 117; allowing containment of any suitable non-flammable gas inserted before test on said semiconductor device is done.

The at least one post-test station 207 comprises of at least one fourth image capturing device 111D configured to capture at least one fourth image of said semiconductor device 103 on said semiconductor device holder on said secondary rotary transfer mechanism when said semiconductor device holder is at said at least one post-test station 207; said fourth image capturing device 111D is configured to transfer captured fourth image to at least one data processing means for image analysis to detect at least one defect on the surface, inside or combination thereof of said semiconductor device 103.

The system 101 of the present invention further comprises of at least one first reject station 125A configured to receive semiconductor devices 103 which fails said test done at said test station 205.

The system 101 of the present invention further comprises of at least one heating element configured to heat said semiconductor device 103 before said semiconductor device 103 is being tested in said test station 205. Preferably, the

heating element should be at the transfer station 201. However, it is possible for said heating element to be disposed at any location so long as heating can be performed on said semiconductor device for the temperature of the semiconductor device to be sufficient for the intended test at the test station 205.

5 While the present invention has been shown and described herein in what are considered to be the preferred embodiments thereof, illustrating the results and advantages over the prior art obtained through the present invention, the invention is not limited to those specific embodiments. Thus, the forms of the invention shown and described herein are to be taken as illustrative only and other embodiments may
10 be selected without departing from the scope of the present invention, as set forth in the claims appended hereto.

WHAT IS CLAIMED IS:

1. A method of testing silicon carbide (SiC) semiconductor device (103),
comprising the steps of:

(i) transferring a semiconductor device (103) from a primary rotary
transfer mechanism (105) to a transfer station (201) at a secondary
rotary transfer mechanism;

(ii) performing testing on said semiconductor device (103) in at least
one test station (205) at said secondary rotary transfer
mechanism;

wherein said semiconductor device (103) is rotary-indexed using said
secondary rotary transfer mechanism to said test station (205);

wherein said step (ii) is repeated for at least one subsequent
semiconductor device (103);

wherein said test station (205) is configured to perform electrical
connectivity test, electrical functionality test, or combination thereof on
said semiconductor device (103).

2. The method of testing silicon carbide (SiC) semiconductor device, as
claimed in Claim 1, wherein said testing in step (ii) is done while another
tested semiconductor device (103) is transferred from said transfer

station (201) to said primary rotary transfer mechanism (105), subsequent untested semiconductor device (103) is transferred from said primary rotary transfer mechanism (105) to said transfer station (201) at said secondary rotary transfer mechanism or combination thereof.

- 5 3. The method of testing silicon carbide (SiC) semiconductor device, as claimed in Claim 1, wherein said at least one test station (205) performs the same or different electrical connectivity test, electrical functionality test or combination thereof.
4. The method of testing silicon carbide (SiC) semiconductor device, as
10 claimed in Claim 1, further comprising of the step of:

 performing pre-test on said semiconductor device (103) in at least one pre-test station (203) at said secondary rotary transfer before performing said testing of said semiconductor device (103) in said at least one test station (205) in step (ii);

15 performing post-test on said semiconductor device (103) in at least one post-test station (207) at said secondary rotary transfer after performing said testing of said semiconductor device (103) in said at least one test station (205) in step (ii); or combination thereof;

wherein said pre-test station (203) is configured to align said semiconductor device (103) at at least one semiconductor device holder at said secondary rotary transfer mechanism;

wherein said post-test station (207) is configured to detect defect on the surface, inside or combination thereof of said semiconductor device (103).

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5. The method of testing silicon carbide (SiC) semiconductor device, as claimed in Claim 1, further comprising of the step of repeating steps (i) to (ii) on at least one more secondary rotary transfer mechanism to perform similar or different test on said semiconductor device (103).

6. The method of testing silicon carbide (SiC) semiconductor device, as claimed in Claim 4, further comprising of the step of repeating step (i) and step (ii) on at least one more secondary rotary transfer mechanism to perform similar or different test on said semiconductor device (103);

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and repeating said pre-testing, post-testing or a combination thereof on at least one more secondary rotary transfer mechanism to perform similar or different test on said semiconductor device (103).

7. The method of testing silicon carbide (SiC) semiconductor device, as claimed in Claim 1, 4, 5 or 6, further comprising of the step of

transferring said semiconductor device (103) which fails said test done at said test station (205) to at least one first reject station (125A).

8. The method of testing silicon carbide (SiC) semiconductor device, as claimed in Claim 1, wherein step (i) comprises of the sub-steps of:

- 5 (a) capturing at least one first image of contact surface (108) of at least one semiconductor device holder at said secondary rotary transfer mechanism when said semiconductor device holder is in said transfer station (201); wherein said contact surface (108) of said semiconductor device holder is configured to be in contact with said semiconductor device; wherein said first image is captured using at
10 least one first image capturing device (111A);
- (b) analysing said first image to detect foreign material at said semiconductor device holder;
- (c) transferring said semiconductor device (103) from said primary
15 rotary transfer mechanism (105) to said semiconductor device holder at said secondary rotary transfer mechanism when said semiconductor device holder is in said transfer station (201); wherein electrical contact points of said semiconductor device (103) when said semiconductor device (103) is at said semiconductor device
20 holder faces away from said semiconductor device holder.

9. The method of testing silicon carbide (SiC) semiconductor device, as claimed in Claim 1, further comprising of heating said semiconductor device (103) using at least one heating element before step (ii).
10. The method of testing silicon carbide (SiC) semiconductor device, as claimed in Claim 4, wherein the following sub-steps are done at said at least one pre-test station (203):
 - (a) capturing at least one second image of said semiconductor device (103) at said semiconductor device holder at said secondary rotary transfer mechanism when said semiconductor device holder is at said at least one pre-test station (203) using at least one second image capturing device (111B);
 - (b) analysing said second image to obtain X-Y coordinate and orientation along X-Y plane of said semiconductor device (103);
 - (c) correcting said X-Y coordinate and orientation along X-Y plane of said semiconductor device (103) to a predetermined X-Y coordinate and orientation along X-Y plane if said X-Y coordinate and orientation along X-Y plane is not within the predetermined range of the intended X-Y coordinate and orientation along X-Y plane;

wherein said sub-steps (a) to (c) are repeated until said X-Y coordinate and orientation along X-Y plane are within a predetermined acceptable range of the intended X-Y coordinate and orientation along X-Y plane.

11. The method of testing silicon carbide (SiC) semiconductor device (103)
5 as claimed in Claim 10, wherein said step of correcting said X-Y coordinate and orientation along X-Y plane of said semiconductor device (103) as in step (c) of the at least one pre-test station (203) is done using a pick-up arm (113) which is configured to pick-up said semiconductor device (103) before changing the X-Y coordinate and
10 orientation along X-Y plane before attaching said semiconductor device (103) back onto said semiconductor device holder.
12. The method of testing silicon carbide (SiC) semiconductor device, as claimed in Claim 1, wherein the following sub-steps are done at said test station (205):
15 (a) capturing at least one third image of at least one test socket (115) and its at least one test socket pin (117); using at least one third image capturing device (111C); wherein said test socket (115) is attached to a tester (119);
(b) analysing said third image to obtain position of said at least one test
20 socket pin (117) with respect to the crosshair of said third image capturing device (111C);

- 5 (c) aligning said test socket pins (117) on test socket (115) to be at the same Z-axis as said semiconductor device (103) and said test socket pins (117) at the same X-Y coordinate as said semiconductor device's (103) corresponding electrical contact points (110) on said semiconductor device (103) using at least one X-Y axis actuator (121);
- 10 (d) transferring said semiconductor device holder with said semiconductor device (103) from said secondary rotary transfer mechanism towards said test socket (115) so that said electrical contact points (110) on said semiconductor device (103) is in contact with their corresponding test socket pins (117);
- 15 (e) inserting any suitable non-flammable gas into a chamber (123) attached to said test socket (115); wherein said chamber (123) encloses said test socket pins (117) and said semiconductor device (103) when said electrical contact points (110) of said semiconductor device (103) is in contact with their corresponding test socket pins (117);
- (f) performing electrical connectivity test and functionality test on said semiconductor device (103) by said tester (119);
- 20 (g) releasing said any suitable non-flammable gas from said chamber (123);

(h) transferring said semiconductor device holder with said semiconductor device (103) to said secondary rotary transfer mechanism.

13. The method of testing silicon carbide (SiC) semiconductor device, as
5 claimed in Claim 12, wherein sub-step (b) of the test station (205) further comprises of analysing said third image to detect at least one abnormal physical property of said at least one test socket pin (117).

14. The method of testing silicon carbide (SiC) semiconductor device, as
10 claimed in Claim 4, wherein the following sub-steps are done at said at least one post-test station (207):

(a) capturing at least one fourth image of said semiconductor device
(103) at said semiconductor device holder at said secondary rotary transfer mechanism when said semiconductor device holder is at said at least one post-test station (207) using at least fourth image
15 capturing device (111D);

(b) analysing said fourth image to detect at least one defect on the surface, inside or combination thereof of said semiconductor device (103).

15. The method of testing silicon carbide (SiC) semiconductor device, as
20 claimed in 14, further comprising the step of transferring said

semiconductor device (103) from said secondary rotary transfer mechanism to at least one second reject station (125B) if at least one defect above acceptable tolerance is detected on the surface, inside or combination thereof of said semiconductor device (103), after step (b) of said at least one post-test station (207).

16. A system of testing silicon carbide (SiC) semiconductor device (103), comprising of:

at least one tester (119) configured to perform electrical connectivity test and functionality test on said semiconductor device (103);

characterized in that

said system further comprises of

an indexable primary rotary transfer mechanism (105);

at least one indexable secondary rotary transfer mechanism configured to receive and transfer said semiconductor device (103) from and to said primary rotary transfer mechanism (105) at a transfer station (201); said secondary rotary transfer mechanism is configured to rotatably transfer said semiconductor device (105) to at least one test station (205);

at least one semiconductor device holder at said primary rotary transfer mechanism (105), secondary rotary transfer mechanism or combination thereof;

wherein said test station (205) comprises of said tester (119) configured to perform electrical connectivity test, electrical functionality test, or combination thereof on said semiconductor device (103);

wherein said electrical connectivity test and functionality test are done in the presence of any suitable non-flammable gas.

10 17. The system of testing silicon carbide (SiC) semiconductor device (103) as claimed in Claim 16, wherein said at least one indexable secondary rotary transfer mechanism further comprises of:

at least one pre-test station (203), at least one post-test station (207) or combination thereof;

15 wherein said at least one pre-test station (203) is configured to align said semiconductor device (103) at at least one semiconductor device holder at said secondary rotary transfer mechanism;

wherein said at least one post-test station (207) is configured to detect defect on the surface, inside or combination thereof of said semiconductor device (103).

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18. The system of testing silicon carbide (SiC) semiconductor device (103) as claimed in Claim 16, wherein said transfer station (201) comprises of at least one first image capturing device (111A) configured to capture at least one first image of contact surface (108) of said semiconductor device holder at said secondary rotary transfer mechanism when said semiconductor device holder is in said transfer station (201); wherein said contact surface (108) of said semiconductor device holder is configured to be in contact with said semiconductor device; said first image capturing device (111A) is configured to transfer captured first image to at least one data processing means for image analysis to detect foreign material on said semiconductor device holder.
19. The system of testing silicon carbide (SiC) semiconductor device (103) as claimed in Claim 17, wherein said at least one pre-test station (203) comprises of:
- at least one second image capturing device (111B) configured to capture at least one second image of said semiconductor device (103) at said semiconductor device holder at said secondary rotary transfer mechanism when said semiconductor device holder is at said at least one pre-test station (203); said second image capturing device (111B) is configured to transfer captured second image to at least one data processing means for image

analysis to determine X-Y coordinate and orientation along X-Y plane of said semiconductor device (103); and

at least one pick-up arm (113) configured to pick-up said semiconductor device (103) to change the X-Y coordinate and orientation along X-Y plane before attaching said semiconductor back onto said semiconductor device holder;

wherein said test station (205) comprises of:

at least one third image capturing device (111C) configured to capture at least one third image of at least one test socket (115) and its at least one test socket pin (117); said third image capturing device (111C) is configured to transfer captured third image to at least one data processing means for image analysis to obtain position of said at least one test socket pin (117) with respect to the crosshair of said third image capturing device (111C); wherein said test socket (115) is attached to said tester (119);

at least one X-Y axis actuator (121) configured to align said test socket pins (117) on test socket (115) to be at the same Z-axis as said semiconductor device (103) and said test socket pins (117) at the same X-Y coordinate as said semiconductor device's (103) corresponding electrical contact points (110);

a chamber (123) attached to said test socket (115) and enclosing said test socket pins (117) and said semiconductor device (103) when said electrical contact points (110) of said semiconductor device (103) is in contact with their corresponding test socket pins (117); allowing containment of any suitable non-flammable gas inserted before test on said semiconductor device is done.

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20. The system of testing silicon carbide (SiC) semiconductor device (103) as claimed in Claim 17, wherein said at least one post-test station (207) comprises of at least one fourth image capturing device (111D) configured to capture at least one fourth image of said semiconductor device (103) at said semiconductor device holder at said secondary rotary transfer mechanism when said semiconductor device holder is at said at least one post-test station (207); said fourth image capturing device (111D) is configured to transfer captured fourth image to at least one data processing means for image analysis to detect at least one defect on the surface, inside or combination thereof of said semiconductor device (103).
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21. The system of testing silicon carbide (SiC) semiconductor device (103) as claimed in Claim 16, further comprises of at least one first reject station (125A) configured to receive semiconductor devices (103) which fails said test done at said test station (205).
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22. The system of testing silicon carbide (SiC) semiconductor device (103) as claimed in Claim 16, further comprises of at least one heating element configured to heat said semiconductor device (103) before said semiconductor device (103) is being tested in said test station (205).
- 5 23. The system of testing silicon carbide (SiC) semiconductor device (103) as claimed in Claim 16, wherein said semiconductor device holder comprises of vacuum mechanism, conductive material, heating element or combination thereof.