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PATENT

IC TESTER JOINED WITH ION BEAM TESTER AND THE DETECTION METHOD OF THE FAILURE PART OF IC

Field of the Invention

5 The present invention relates to an IC tester joined
with an ion beam tester which irradiates an ion beam to a
device under test (hereinafter refer to DUT) and measures
quantity of secondary electrons generated by the ion beam at
an irradiated point and displays a contrast image of a
10 distribution of electrical potentials on the IC, and to a
detection method of failure part of the DUT.

Background of the Invention

15 An IC tester is already realized for analyzing the
failure of a DUT which is irradiated by a sweeping electric
charged particle beam and measuring the quantity of the
secondary electrons which are generated at each irradiated
point by the beam. The IC tester obtains these measured
parameters as an electrical signal of distribution voltage
potential on the DUT and displays a corresponding voltage
20 contrast image.

Figure 13 shows an outline of construction for a kind of
conventional IC tester. A numeral 100 in the figure shows an
overall structure of an IC analysis system. The IC analysis
system 100 can be classified into two blocks which comprises
25 a test pattern generator 200 and an electric charged particle
beam system 300.

The test pattern generator 200 provides a pattern signal
to the DUT which is set in the ion beam tester 300. A
conventional test pattern generator 200 comprises a start
30 switch 201 which can start generation of a test pattern and,
a stop switch 202 which can stop generation of the test
pattern. The pattern generator 200 further includes a stop
pattern setting means 203 which can be stopped a renewal of
the test pattern when a specified test pattern is generated
35 and, and a pattern hold means 204 which can stop renewal of
the test pattern by detecting generation of the test pattern



which is set in the stop pattern setting means 203. A stop
signal occurrence means 205 is provided which generates a
signal is indicated stop of renewal of the test pattern and,
can execute start and stop control of generation of the test
5 pattern signal and stop of the renewal operation of the test
pattern in the part of detection test pattern.

An ion beam tester 300 comprises a mirror pipe
department 301 which irradiates ion beam to the DUT, a
chamber 302 which keeps the DUT in a vacuum environment and
10 is located under the mirror pipe department 301, a stage 303
which moves position of the DUT for X-Y direction and is
located in the chamber 302. The ion beam tester 300 further
includes a sensor 304 which measures quantity of the
secondary electron is generated by the DUT, and an image data
15 acquisition device 305 which is obtained image data is
detected as an electrical signal by the sensor 304. A
monitor 306 is provided which displays a potential contrast
image which is derived from image data processed by the image
data acquisition device 305. A mirror pipe control unit 307
20 is further provided which controls emission of the ion beam,
its quantity of the emission (current value), acceleration
voltage, scanning speed and scanning area.

When the pattern hold means 204 detects generation of
the test pattern which is specified to the stop pattern
25 setting means 203, the test pattern generator 200 temporarily
stops a renewal operation for the test pattern and
continuously outputs the test pattern which is specified to
the stop pattern setting means 203. The image data
acquisition device 305 and the mirror pipe control unit 307
30 are provided with a stop signal from the stop signal
occurrence means 205 which indicates a stop of the renewal
operation of the test pattern. The mirror pipe control unit
307 controls the ion beam emission after receiving the stop
signal and the image data acquisition device 305 starts
35 obtaining the image data.



5 A detection procedure for failure part of the IC is performed by setting the test pattern which has detected a failure device tested by the IC tester beforehand to the stop pattern setting means 203. When the pattern hold means 204
10 detects generation of the failure detecting test pattern which is specified in the stop pattern setting means 203, the test pattern generator 200 temporarily stops the renewal operation for the test pattern and continuously outputs the test pattern. The mirror pipe control unit 307 executes the
15 emission control of the ion beam after received the stop signal and, the image data acquisition device 305 starts obtaining the image data. Above mentioned procedure for obtaining the image data is executed for both good devices and failure devices and, the image data acquisition device
305 compares, operates and, determines a failure part which is a part showing a difference between the good device and the failure device.

20 In this kind of conventional IC tester, a stopping time of the test pattern is set slightly longer than a time required for obtaining the image data. Because of this reason, when obtaining conditions of the image data, it is necessary to change the stopping time of the test pattern, which lowers an operability of the IC tester.

25 Namely, the acceleration voltage, the scanning speed, the scanning area and the number of scan of the ion beam must be specified for obtaining the image data. And when these specified parameters are changed, a time required for obtaining the image data will also be changed. For this reason, if the conditions for obtaining the image data have
30 to be changed, then the stop time of the test pattern must also be changed. Therefore, both the test pattern generator 200 and the ion beam tester 300 must be operated, which requires complicated operational procedures.

35 On the other hand, obtaining the condition of the image data is necessary to change for various purpose of test. In particular, if the DUT is an IC chip which is covered by an



insulation film on its surface as a protection layer, electrical potentials of conductor wires which is buried under such an insulation film have to be observed. However, it is difficult to obtain an electrical potential distribution as a contrast image of an electrical potential of conductor wire on the IC which surface is covered by the insulation film. Namely, the ion beam is irradiated to the surface of the isolation film then the electrical potential distribution will be faded out in proportion to the irradiation time of the ion beam by the storage of the charge on the isolation film. Therefore, there is a problem in that an accurate electrical potential image will not be obtained.

Figure 14 shows this situation. Figure 14A shows the electrical potential contrast image in case of a logical L, logical H, logical L and logical H are respectively provided conductors L1, L2, L3 and L4 existing under the isolation film. The logical L of the electrical potential (nearby 0 volt or negative voltage) is provided then the electrical potential contrast image is displayed by white color (detected secondary electron by a sensor 304 is large) as shown in figure. The logical H of the electrical potential (higher positive voltage than 0 volt) is provided then the electrical potential contrast image is displayed by black color (detected secondary electron by a sensor 304 is small). Here, isolated substrate PB becomes an intermediate level between the electrical potentials of the logical L and the logical H, and is displayed by gray color.

Figure 14B shows a condition just after (0.1 to 0.3 second after) the end of the irradiation and scanning of the ion beam. The electrical potential contrast goes down rapidly and disappears after few seconds from the start of irradiation and its scanning of the ion beam as shown in Figure 14C. Accordingly, obtaining the image data is effective only in the condition as shown in Figure 14A. Majority of the image data cannot be obtained because a time of existing of the electrical potential contrast is too short



and, it is difficult to obtain a clear image by obtaining image data at one time.

5 There need frequent changes in the conditions for the obtaining the image data (i.e., scanning area of the ion beam, the ion beam current and etc.) because a phenomenon of deterioration of the electrical potential contrast is existence. Accordingly, specifying the stop time of the test pattern needs to change as often as obtaining the image data, thus, the operability of the IC tester is deteriorated.

10 Summary of the Invention

Therefore, it is an object of the present invention to provide an improve IC tester having an electron beam tester which is capable of obtaining a clear electrical potential contrast image even if a quality of an electrical potential contrast is lowered.

15 It is another object of the present invention to provide an improved method of detecting a failure part of an IC device by an IC tester having an electron beam tester.

20 It is a further object of the present invention to improve the quality of the electrical potential contrast image which displays an electrical potential distribution of wiring conductors in an IC device under test which is provided with a desired test pattern.

25 An electrical potential contrast image is obtained by secondary electrons as an image data which are generated by scanning of irradiation of the ion beam to a partial area of a DUT which is provided with a predetermined test pattern. However, in the case of the IC chip which is covered by an insulation film on a surface as above mentioned, there is a
30 phenomenon of deterioration of the electrical potential distribution which is composed on the insulation film in proportion to the quantity of the irradiation of the ion beam. For this reason, obtaining the image data is limited only first time of the irradiation and scanning of the ion
35 beam. Since the image data is obtained only one time of the irradiation and scanning of the ion beam, and the image data



is read and is displayed on a monitor as an electrical potential contrast, there exist insufficiencies in the potential contrast that the detailed part of the displayed image data is not clearly observable because of the insufficient amount of image data.

As for a method of improvement to this defective, there is a method which renews the test pattern in sequence, irradiates and, scans the ion beam continuously for attaining to the specific test pattern n. According to this method, the electrical potential of the covered isolation film on the IC chip becomes a mean value of dynamic change of the electrical potential on the wiring conductor, namely, it is an intermediate value between logical H and logical L. Therefore, the electrical potential distribution is determined by the test pattern and, the electrical potential contrast image can be obtained when if renewal operation of the test pattern is stopped at a target test pattern n. The renewal operation of the test pattern is started again after the obtaining the image data.

According to above-mentioned operation is repeated, it is possible to obtain the electrical potential contrast image which is the state in the application of the desired test pattern and, to make a lot of image data and to improve the electrical potential contrast image by an average processing and etc.

However, there is a following disadvantage in this method. That is, when the renewal operation is stopped at a predetermined test pattern, because of the electrical potential immediately prior to the stop, the potential contrast becomes unsuitable wherein there exist both appearance and disappearance of the conductors. The reason of the both appearance and disappearance of the conductors for the electrical potential contrast image should be understood by the explanation of principle operation of the present invention.



5 The present invention provides an apparatus which is to improve an operability and a quality of the electrical potential contrast image and, an effective method which is to determine the failure part of the DUT. Namely, the present invention basically comprised of an ion beam tester which reproduces an electrical potential distribution in the DUT which is irradiated and swept by the ion beam and is measured a quantity of secondary electrons which are generated from each irradiated point, and an IC tester which composes a test
10 pattern generator which supplies a test pattern to the DUT.

The apparatus of the present invention includes a stop pattern set up means which specifies the test pattern to be stopped to the test pattern generator, a pattern hold means which temporarily hold renewal operation of the test pattern
15 generation at the specified test pattern by the stop pattern set up means, a stop signal generator means which outputs a pattern stop signal which indicates the stop of the renewal operation of the test pattern and, a release means which releases the hold condition of a test hold means which is provided an obtaining completion signal which means
20 completion of the image data from the ion beam tester, the image data obtaining means which receives the pattern stop signal is generated by the stop signal generator means and starts obtaining the image data in the ion beam tester and, an obtaining completion signal generator means which
25 generates an obtaining completion signal indicating an completion of obtaining the image data by the image data obtaining means.

According to above-mentioned configuration, the obtaining completion signal generator means generates
30 obtaining completion signal which indicates obtaining of completion of the image data when the desired image data is obtained by the image data obtaining means. By this acquisition completion signal, a pattern generator starts a renewal action of the test pattern. Accordingly, test
35



pattern suspension time need not to be set up to the test pattern generator according to this constitution.

5 The acquisition of image data and an automatic start and stop action of the test pattern are repeated. No human assistance is required. Also by setting up the occurrence of a test pattern to a repeat generation mode, image data of the condition that is derived under the same test pattern can be acquired repeatedly.

10 A further purpose of this invention is to improve an image quality by supplementing a reduction in the potential contrast. For doing this, the apparatus of this invention is configured to set up at least two test patterns in the suspension pattern setting means of the test pattern generator. Whenever the 1st test pattern and the 2nd test
15 pattern occur a renewal action of a test pattern, the suspension is caused. At the time of the 1st test pattern occurrence and the 2nd test pattern occurrence together, the irradiation of an ion beam and the acquisition of the image data are implemented. Furthermore, a difference of the image
20 data under the condition of driving different test patterns is obtained.

Like this, at the time of the 1st test pattern occurrence and the 2nd test pattern occurrence, an action of ion beam irradiation and sweep, and an acquisition of the
25 image data are implemented. By computing a difference of the image data that is obtained at the time of the 1st test pattern driving and the 2nd test pattern driving, the only part that changed the potential can be indicated as a potential contrast image.

30 In this case, a difference between the two images data is computed. Therefore, a potential contrast of the part that a potential is reversed at the time of driving of the 1st test pattern and the 2nd test pattern is obtained with emphasis. Thus, a quality of the image is improved and a
35 clear image can be obtained.



For specifying a defective part of an IC under test, a power supply for the IC under test is turned off at the time of the 1st test pattern r. In this way, the logic of a wiring conductor under the test pattern r is fixed to L logic and its image is taken in. Then the power supply is turned on for the 2nd test pattern n and the image is taken in. Like this, a difference in the images will appear to a contrast image without fail, when there was difference in logic between a normal part and a defective part in the IC device. Therefore, the defective part of the IC under test can be specified by the difference in the potential contrast images between the normal part and the defective part.

Brief Description of the Drawings

Figure 1 shows a block diagram showing one embodiment of this invention.

Figure 2 shows a waveform figure showing an action of the embodiment of Figure 1.

Figure 3 shows another waveform figure showing an action of the embodiment of Figure 1.

Figure 4 shows a waveform figure showing an action of this method invention.

Figure 5 shows another waveform figure showing an action of this method invention.

Figure 6 shows a plane figure showing the potential that is given to the wiring inside device under test driving test pattern r at Figure 1.

Figure 7 shows a plane figure showing the potential that is given to the wiring inside device under test driving test pattern n at Figure 1.

Figure 8 shows a front figure showing a potential contrast image that is obtained in condition of driving test pattern r, after derived test pattern r and n alternately at Figure 1.

Figure 9 shows a front figure showing a potential contrast image that is obtained in condition of driving test



pattern n, after driving test pattern r and n alternately at Figure 1.

5 Figure 10 shows a front figure showing a potential contrast that reversed the polarity of a potential contrast at Figure 8.

Figure 11 shows a front figure showing as the potential contrast the result that was computed by computation means at Figure 1.

10 Figure 12 shows a waveform figure that explains the reason why the potential contrast of the part that a potential of same polarity is given disappears, when test pattern r and n are derived alternately at Figure 1.

Figure 13 shows a block diagram showing conventional technology.

15 Figure 14 shows a front figure showing an example of such potential contrast image that explains a disadvantage of conventional technology.

Detailed Description of the Invention

20 A block diagram of an IC test system of the present invention is shown in Figure 1. The part that corresponds with Figure 13 is shown with the same reference numeral. The structure that makes this IC test system 100 characteristic is that it includes a complete signal occurrence means 308 that transmits an acquisition completion signal that shows acquisition completion of image data to an ion beam tester 25 300, a plurality of image data acquisition means 305A and 305B, and a computation means 309 that acquires the difference in the image data between said image data acquisition means 305A and 305B.

30 In this embodiment, a complete signal occurrence means 308 detects that the acquisition of image data has been completed in the image data acquisition means 305A and 305B. And it transmits an acquisition completion signal in this detection point. This acquisition completion signal inputs 35 to a pattern hold means 204 that is provided on the side of a test pattern generator 200.



5 A pattern hold means 204 gives the command that cancels the suspension of a test pattern to the test pattern generator 200 through the means that an acquisition completion signal is input. Test pattern generator 200 starts a renewal action of a test pattern that was released from suspension condition.

10 Namely, if suspension patterns r and n are set in a suspension pattern setting means 203, the IC test system maintains the condition where test pattern r or n is output and causes a suspension of the test pattern renewal action in the test pattern generator 200 and the pattern hold means 204 work whenever this suspension patterns r and n occur. This situation is shown in Figure 2. As for Figure 2A, a start signal is shown, and Figure 2B a test pattern signal is shown. It maintains condition where pattern r or n is output and pattern hold means 204 cause a renewal action of the test pattern generator 200 patterns a momentary stop, when a test pattern signal reaches the suspension pattern r or n (the address where shows a pattern occurrence order generally is indicated). A suspension signal is output from a stop signal occurrence means 205 together in this moment. This suspension signal is input to an image data acquisition device 305 and start getting the image data. Figure 2F shows an acquisition action period of image data.

25 A fetch completion of image data can be known by, for example, detecting a vertical retrace line signal that shows that sweep irradiation of an ion beam reached in one screen. When the ion beam scans an arbitrary number of screens such as one to several screens, by causing an acquisition completion signal a transmission when a vertical retrace line signal is detected 1 or optional number, an acquisition completion signal can be caused a transmission. An acquisition completion signal is shown in Figure 2G.

35 Through the means that an acquisition completion signal is given to the pattern hold means 204, the test pattern signal generator 200 are released from the suspension



condition. As shown in Figure 2B, the test patterns are renewed as 'r+1, r+2, --- or n+1, n+2 ---, and are output to the final pattern "Last". The test patterns hold in final pattern "Last" where the number of test pattern occurrence is set to one.

In case of generating a test pattern continuously, or setting the restart address after image data acquisition return to an initial pattern, as shown in figure 3, the pattern generation suspends automatically when test pattern r is produced, and then returns to the initial pattern when the acquisition of image data completes. The pattern generation continues and until it reaches the test pattern n. Then the pattern generation returns to the initial pattern once again after the acquisition of image data. The generating of the pattern is repeated in this manner. Thus, the image data under this condition where the special test patterns r and n are used is acquired several times automatically. This operation can be finished by executing a stop switch 202.

According to this device like this, if observing a potential contrast image, and setting a standard pattern r, and a test pattern n, in the suspension pattern setting means 203, the test pattern generator 200 triggering and a suspension action interlock to an acquisition action of image data on the side of the ion beam tester 300. Therefore, the settings in test pattern generator 200 and also in the ion beam tester 300 need not to be changed even if an acquisition condition of image data has to be changed. Therefore, the operation is simplified and the operability can be improve.

One of the features of the present invention is an ability of comparing a potential contrast of a non-defective and defective parts by utilizing this improved IC test system, and obtaining the method that is possible to specify a defective part of an IC under test. Different image data of condition is acquired by the plural image data acquisition means 305A and 305B, as shown in Figure 1. Namely, the image

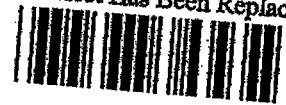


data under the condition where the gave test pattern r is given to the device under test DUT is taken in the image data acquisition means 305A. Also the image data under the condition where the test pattern n is given to the device under test DUT is taken in the image data acquisition means 305B.

The image data that acquired in the image data acquisition means 305A is reversed in the polarity and given to a computation means 309. The image data that taken in the image data acquisition means 305B is given as it is to the computation means 309. The image data that was given from the image data acquisition means 305A and 305B are added in the computation means 309. The addition result is indicated on a monitor 306. By indicating the computation result by the computation means 309 to the monitor 306, a potential contrast image will be developed to a clear image. The reason is explained below.

Figure 6 shows the image that is given to wiring conductors L1, L2, L3, L4 inside the device under test DUT when the test pattern r is given. Namely, in the example of Figure 6, a situation where the conductor L1 is L logic, the conductor L2 is H logic, the conductor L3 is L logic, and the conductor L4 is H logic. On the other hand, Figure 7 shows the potential that is given to the wiring conductors L1-L4 inside the device under test DUT when test pattern n is provided. In Figure 7, the conductor L1 is L logic, the conductor L2 is L logic, the conductor L3 is H logic, and the conductor L4 is H logic.

These potential contrast images are shown in Figure 8 and Figure 9. Figure 8 shows a potential contrast image when the test pattern r is given to the DUT. Figure 9 shows a potential contrast image when the test pattern n is given to the DUT. In Figure 8, the potential contrasts of the conductors L1 and L4 are disappearing in the potential contrast image while only the potential contrasts of the conductors L2 and L3 remain. In Figure 9, the potential



contrasts of the conductors L1 and L4 disappear while only the potential contrasts of the conductors L2 and L3 are left. The reason for this is that the potential that is given to the conductors L1 and L4 at the time of providing the test pattern n is the same as that of the time of providing the test pattern r.

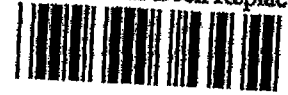
Figure 12 shows a timing chart for explaining the situation where the potential contrast disappears. Figure 12A shows an ion beam irradiation period, and a period of the test pattern r and n. Figure 12B shows a potential contrast that occurs in an insulation layer which exists on the surface of the conductor L1.

Figure 12C shows a potential contrast that occurs in an insulation layer which exists on the surface of the conductor L2. Figure 12D shows a potential contrast that occurs in an insulation layer which exists on the surface of the conductor L3. Figure 12E shows a potential contrast that occurs in an insulation layer which exists on the surface of the conductor L4.

A potential contrast occurs at the first time when the test pattern r is given as shown in Figure 12B and Figure 12E. After that, there is no occurrence of the potential contrast, because a potential of same direction is given when test pattern n is given. By the irradiation of the ion beam, the potential contrast changes in a direction where the contrast disappears and converges to a balanced potential VS. After that, a potential contrast does not occur in an insulation layer which on the surface of the conductors L1 and L4 even if the test patterns r and n are applied to the conductors alternately.

In contrast, whenever the test patterns r and n are given to the insulation layer on the surface of conductors L2 and L3, the potential contrast is produced since the potentials of opposite polarity are given to the conductors.

Therefore, a potential contrast of opposite polarity occurs whenever the test patterns r and n are given. The



reason that potential contrasts of conductor L1 and L4 disappear is understandable by the aforementioned explanation. By reversing either one of the remaining potential contrasts, i.e., the image data (the same as the
5 potential contrast) obtained in the image data acquisition means 305A in this example and providing this image data to the computation means 309, the image data is added to the image data from the acquisition means 305B.

Figure 10 shows the image data which is reversed in
10 polarity of the image data (potential contrast) that acquired in the image data acquisition means 305A. The image data shown in Figure 11 is obtained by adding the image data shown in Figure 9 and the image data shown in Figure 10. The image data of Figure 11 is fit and is added regarding a potential
15 contrast of conductor L2 and L3 and is emphasized. Accordingly, quality of the image improves. A good potential contrast image of a higher resolution can be obtained.

Next, it is explained about an invention of the method for specifying a defective part of the IC device under test
20 by using the above described ion beam tester 300. At first, Table 1 showing relationship between logic signals and potential contrast images in an excellent quality IC and an inferior quality IC is given below.



Table 1:

Concerning Good DUT and bad DUT, a correspondence between a logic signal and a potential contrast picture.

term	good DUT			bad DUT			difference picture of good/bad DUT	problem on fail detection
	r pat	n pat	potential contrast picture	r pat	n pat	potential contrast picture		
1	H	H	grey	H	L	white	exist	non
2				L	L	grey	non	exist
3				H	H	grey	non	non
4				L	H	black	exist	non
5	L	H	black	H	L	white	exist	non
6				L	L	grey	exist	non
7				H	H	grey	exist	non
8				L	H	black	non	non
9	H	L	white	H	L	white	non	non
10				L	L	grey	exist	non
11				H	H	grey	exist	non
12				L	H	black	exist	non
13	L	L	grey	H	L	white	exist	non
14				L	L	grey	non	non
15				H	H	grey	non	exist
16				L	H	black	exist	non

A pattern of a logic signal is a combination of H logic and L logic. When the same potential is given at the time of the 2nd test pattern n at the time of the 1st test pattern r, a gray potential contrast image is obtained. When H logic is



given at the time of 2nd test pattern n, while L logic is given at the time of 1st test pattern r, a potential contrast image of a black color is obtained. When L logic is given at the time of 2nd test pattern n, while H logic is given at the time of 1st test pattern r, a potential contrast image of a white color is obtained.

By utilizing this relationship, and by comparing a potential contrast image of the logic signal of an excellent article with an inferior quality article, it is possible to identify a defective part of the IC under test. Table 1 shows a combination of a logic pattern that is able to break out to an excellent article and an article of inferior quality. Table 1 also shows a presence of problem on detection malfunction, presence of difference of potential contrast image of an excellent article and article of inferior quality. As for Table 1, items 3, 8, 9 and 14, an image becomes the same because a logic signal of an excellent article and an article of inferior quality are the same. A problem in detecting the defects relates to items 2 and 15. Namely, logic level of each test pattern is different with an excellent article and an article of inferior quality namely, nevertheless, it does not appear as a difference. This invention is the method that the problem on this defects detection is obviated.

Figure 5 shows waveforms for explaining an operation of the present invention. The feature of this invention is to control the power supply of device under test to off at the time of the 1st test pattern r. Irradiating and scanning an ion beam in the condition the image data acquisition is implemented. It always becomes L logic due to the condition of the power supply off at the time of the 1st test pattern r. Finishing the 1st test pattern r, next the power supply is done to on at the time of the 2nd test pattern n. Irradiating and scanning an ion beam the image data acquisition is implemented. An example of the method that repeats and measures off, on of this power supply is shown in



figure 4. Expressing a presence of problem on detection malfunction, presence of difference of potential contrast image of an excellent article and article of inferior quality with, a method in this invention is shown in 2.



Table 2:

Concerning Good DUT and bad DUT, a correspondence between a logic signal and a potential contrast picture.

(the power supply off at the time of r pattern)

term	good DUT			bad DUT			difference picture of good/bad DUT	problem on fail detection
	r pat	n pat	potential contrast picture	r pat	n pat	potential contrast picture		
1	L	H	black	L	L	grey	exist	non
2				L	L	grey	exist	non
3				L	H	black	non	non
4				L	H	black	non	non
5	L	H	black	L	L	grey	exist	non
6				L	L	grey	exist	non
7				L	H	black	non	non
8				L	H	black	non	non
9	L	L	grey	L	L	grey	non	non
10				L	L	grey	non	non
11				L	H	black	exist	non
12				L	H	black	exist	non
13	L	L	grey	L	L	grey	non	non
14				L	L	grey	non	non
15				L	H	black	exist	non
16				L	H	black	exist	non

As shown in table 2 a problem on malfunction detection disappears. A difference of image of an excellent article and article of inferior quality are obtained certainly. By



comparing the potential contrast, a defective part certainly special of IC can be made.

5 As described above, according to this invention, by applying different test patterns alternately, for example the patterns r and n, and displaying a difference of the potential contrast, the potential contrast image is substantially improved than just applying only one test pattern. The potential distribution in the wiring conductors inside of the IC chip can be analyzed with higher accuracy because of this improved contrast image. Therefore, it is also possible to identify a defective part of the IC chip in a short period of time.

15 It is also possible to observe other potential contrast images of conductors which is not observable under the test pattern r and n by selecting other combination of the test patterns. Furthermore, by repeatedly applying the same test pattern, for example, the pattern n, to the DUT and changing the value of the supply voltage of DUT, an abnormal action is caused alternately at every test pattern suspension. Thus, it can produce a potential contrast to only the part that does an abnormal action. Accordingly, in this case, the advantage that can make a defective place directly special is obtained.

25 Also it fixes the logic of a wiring conductor in the 1st test r pattern to L logic by turning off the power supply of device under test, to when an ion beam irradiation scanning, image data acquisition at the time of the 1st test pattern r is carried out and make the power supply on in the 2nd test pattern n and can take in the image. A difference image appears to a potential contrast image without fail an excellent article of this image in the case of an when there is difference in both by a comparison of case of an article of inferior quality. Therefore the advantage that can make a defective part special of IC is obtained. A big effect is able to be demonstrated to an analysis of the malfunction of device under test IC.



What is claimed is:

1. An IC analysis system (100) that is composed of a test pattern generator (200) which gradually renew and give a test patter signal to the device under test, and of an ion beam tester (300) which sweeps and irradiates an ion beam on the surface of the device under test, and which indicates and make potential distribution of the device under test surface an image after measuring a volume of 2nd electrons that occurs from each irradiation point, comprising;

on the above test pattern generator (200) side, stop pattern setting means (203) that set up at least 2 pieces of test patterns where should stop a pattern renewal action of said test pattern generator (200);

pattern hold means (204) that cause a renewal action of the test pattern a momentary stop in the condition whenever said test pattern generator (200) produce each test pattern where set up in the said stop pattern setting means (203);

stop signal occurrence means (205) which output a pattern stop signal that shows it whenever a renewal action of said test patter suspends it;

in the said ion beam tester (300),

at least image data acquisition means (305A, 305B) which take in each image data, answering to the pattern stop signal that was supplied by said stop signal occurrence means (205);

computation means (309) that compute a difference of the image data that acquired it to said 2 image data acquisition means; and

monitor (306) that indicate image data of the difference that computer it in said computation means (309).

2. The IC analysis system (100) as claimed 1,

wherein said ion beam tester (300) includes the acquisition completion occurrence means (308) that produce said acquisition completion signal that shows it



if each said image data acquisition means (305A, 305B) completes the acquisition of image data; and

5 said pattern hold means (204) are composed that a pattern renewal of said test pattern generator (200) is caused resumption when a supply of an acquisition completion signal that shows acquisition completion of image data from said ion beam tester (300) is received.

10 3. An ion beam tester (300) which is composed with test pattern generator (200) which drives a test pattern to device under test, as IC test device (100), irradiating an ion beam on the surface of device under test, and indicating and make potential distribution of said DUT surface a image by measuring a volume of 2nd electrons that occurs from each irradiation point, comprising;

15 at least 2 image data acquisition means (305A, 305B) which take in the image data that acquired it individually, answering to a patten stop signal that was supplied each in 2 stop patterns at least by said test pattern generator (200);

20 computation means (309) that computes a difference of the image data that acquired it to said 2 image data acquisition means (305A, 305B); and

25 monitor (306) that indicate image data of the difference that computed it in said computation means (309).

4. The ion beam tester (300) as claimed 3,

30 wherein said ion beam tester (300) includes write complete signal occurrence means (308) which generates an acquisition write completion signal, in order to supplies to said test pattern generator (200), whenever said data acquisition means (305A, 305B) completes the acquisition of image data.

35 5. A method of specifying a defective part of the device under test IC, composing with test pattern generator (200) which drives a test pattern to device under test as IC test device (100), at the ion beam tester (300) which



irradiates an ion beam on the surface of said DUT, and measures a volume of 2nd electrons that occurs from each irradiation point, where indicates and makes potential distribution of said DUT surface, comprising the steps of;

5 taking in at least 2 suspension patterns, that image data in the 1st test pattern r and the 2nd test pattern n;

turning off the power supply of said DUT, at the time of said 1st test pattern r at least, irradiating an ion beam, and taken in the 1st image;

10 turning on the power supply of said DUT, at the time of at least said 2nd test patten n to said DUT, irradiating an ion beam, and taken in the 2nd image;

computing the difference of said 1st image and said 2nd image; and

15 defining special position different from an image of said difference of excellent article IC a defective part of said measurement IC, and an image of said difference of said DUT.