PLANAR VOLTAGE CONTRAST TEST STRUCTURE ~~AND METHOD~~

CROSS-REFERENCE TO RELATED APPLICATION(S)

This is a divisional of co-pending application serial number 10/703,285 filed November 6, 2003, now U.S. Patent number 7,160,741, which is hereby incorporated by reference thereto.

TECHNICAL FIELD

The present invention relates generally to semiconductor testing, and more particularly to test structures used in such testing.

BACKGROUND ART

In the semiconductor integrated circuit (IC) industry, there is a continuing demand for higher circuit packing densities. This demand of increased packing densities has led the semiconductor industry to develop new materials and processes to achieve sub-micron device dimensions. Manufacturing ICs at such minute dimensions adds more complexity to circuits and increases the demand for improved methods to inspect integrated circuits in various stages of their manufacture.

As design rules and process windows continue to shrink, IC manufacturers face many challenges in achieving and maintaining yields and profitability while moving to new process technologies such as larger wafers, copper interconnect, and low-k dielectrics. Additionally, defects that were not relevant in the older, larger design rules have now become problems as design rules are reduced to 0.13 μm geometries and below.

Although inspection of such products at various stages of manufacture is very important and can significantly improve production yield and product reliability, the increased complexity of ICs increases the cost of such inspections, both in terms of expense and time. However, if a defect can be detected early in production, the cause of the defect can be determined and corrected before a significant number of defective ICs are manufactured.

In order to overcome the problems posed by defective ICs, IC manufacturers fabricate test structures. Such test structures are used in defect analysis. The test structures

are fabricated such that they are sensitive to defects that occur in IC products, but are designed so that the presence of defects is more readily ascertained. Such defect test structures often are constructed on the same semiconductor substrate as the IC products.

Defect detecting systems frequently utilize charged particle beams. In such systems, a charged particle beam, such as an electron beam, is irradiated on defect test structures. The interaction of the electron beam with features in the circuitry generates a number of signals in

~~THE INVENTION CLAIMED IS:~~

1. A method of testing an integrated circuit using an e-beam tester comprising:

providing a ground grid;

providing a metal pad having a space therein and positioned within the ground grid;

providing a metal line connected to the ground grid and positioned in the space; and

processing the integrated circuit with the e-beam tester.

2. The method of testing an integrated circuit using an e-beam tester as claimed in claim 1 wherein providing a metal line connected to the ground grid provides a metal line that is not electrically connected to the metal pad, whereby, upon the occurrence of an electrical short circuit between the metal line and the metal pad, the metal pad appears bright under the influence of the e-beam tester.

3. The method of testing an integrated circuit using an e-beam tester as claimed in claim 1 wherein providing a metal line connected to the ground grid provides a metal line that is electrically connected to the metal pad, whereby upon the occurrence of an electrical open circuit between the metal line and the metal pad, the metal pad appears dark under the influence of the e-beam tester.

4. The method of testing an integrated circuit using an e-beam tester as claimed in claim 1 wherein providing a metal line provides a metal line of at least one of a T-shaped line, an obtuse-angled line, a right-angled line, a straight line, a serpentine line, an interleaved comb, and combinations thereof.

5. The method of testing an integrated circuit using an e-beam tester as claimed in claim 1 further comprising;

providing a second metal pad having a space therein positioned within the ground grid; and

providing a second metal line within the ground grid, wherein the second metal line is connected to the ground grid and spaced from the second metal pad.

6. A method of testing an integrated circuit using an e-beam tester comprising:

providing a ground grid;

providing a plurality of metal pads each having a space therein and positioned within the ground grid;

providing a plurality of metal lines within the ground grid, wherein each of the plurality of metal lines is connected to the ground grid, associated with one of the plurality of metal pads, and positioned within the space of its associated one of the plurality of metal pads; and

processing the integrated circuit with the e-beam tester.

7. The method of testing an integrated circuit using an e-beam tester as claimed in claim 6 wherein providing a plurality of metal lines within the ground grid provides at least a portion of the plurality of metal lines that is not electrically connected to an associated metal pad, whereby, upon the occurrence of an electrical short circuit between a portion of the metal lines and the associated metal pad, the associated metal pad appears bright under the influence of the e-beam tester.

8. The method of testing an integrated circuit using an e-beam tester as claimed in claim 6 wherein providing a plurality of metal lines within the ground grid provides at least a portion of the plurality of metal lines that is electrically connected to an associated metal pad, whereby upon the occurrence of an electrical open circuit between a portion of the metal lines and the associated metal pad, the associated metal pad appears dark under the influence of the e-beam tester.

9. The method of testing an integrated circuit using an e-beam tester as claimed in claim 6 wherein providing a plurality of metal lines provides a plurality of metal lines of at least one of a T-shaped line, an obtuse-angled line, a right-angled line, a straight line, a serpentine line, an interleaved comb, and combinations thereof.

10. The method of testing an integrated circuit using an e-beam tester as claimed in claim 6 wherein at least a first portion of the plurality of metal lines is not electrically connected to their associated metal pads; and at least a second portion of the plurality of metal lines is electrically connected to their associated metal pads.

11. An integrated circuit for testing using an e-beam tester comprising:

a ground grid;

a metal pad having a space therein and positioned within the ground grid; and

a metal line connected to the ground grid and positioned in the space.

12. The integrated circuit for testing using an e-beam tester as claimed in claim 11 wherein the metal line connected to the ground grid is a metal line that is positioned in the space and not electrically connected to the metal pad, whereby, upon the occurrence of an

electrical short circuit between the metal line and the metal pad, the metal pad appears bright under the influence of the e-beam tester.

13. The integrated circuit for testing using an e-beam tester as claimed in claim 11 wherein the metal line connected to the ground grid is a metal line that is positioned within the space and electrically connected to the metal pad, whereby upon the occurrence of an electrical open circuit between the metal line and the metal pad, the metal pad appears dark under the influence of the e-beam tester.

14. The integrated circuit for testing using an e-beam tester as claimed in claim 11 wherein the metal line is a metal line of at least one of a T-shaped line, an obtuse-angled line, a right-angled line, a straight line, a serpentine line, an interleaved comb, and combinations thereof.

15. The integrated circuit for testing using an e-beam tester as claimed in claim 11 further comprising;

a second metal pad having a space therein positioned within the ground grid; and

a second metal line within the ground grid, wherein the second metal line is connected to the ground grid and positioned within the space.

16. An integrated circuit for testing using an e-beam tester comprising:

a ground grid;

a plurality of metal pads each having a space therein and positioned within the ground grid; and

a plurality of metal lines within the ground grid, wherein each of the plurality of metal lines is connected to the ground grid, associated with one of the plurality of metal pads, and positioned within the space of its associated one of the plurality of metal pads.

17. The integrated circuit for testing using an e-beam tester as claimed in claim 16 wherein the plurality of metal lines within the ground grid comprises at least a portion of the plurality of metal lines that is not electrically connected to an associated metal pad, whereby, upon the occurrence of an electrical short circuit between a portion of the metal lines and the associated metal pad, the associated metal pad appears bright under the influence of the e-beam tester.

18. The integrated circuit for testing using an e-beam tester as claimed in claim 16 wherein the plurality of metal lines within the ground grid comprises at least a portion of the

plurality of metal lines that is electrically connected to an associated metal pad, whereby upon the occurrence of an electrical open circuit between a portion of the metal lines and the associated metal pad, the associated metal pad appears dark under the influence of the e-beam tester.

19. The integrated circuit for testing using an e-beam tester as claimed in claim 16 wherein the plurality of metal lines is a plurality of metal lines of at least one of a T-shaped line, an obtuse-angled line, a right-angled line, a straight line, a serpentine line, an interleaved comb, and combinations thereof.

20. The integrated circuit for testing using an e-beam tester as claimed in claim 16 wherein at least a first portion of the plurality of metal lines is not electrically connected to their associated metal pads; and at least a second portion of the plurality of metal lines is electrically connected to their associated metal pads.

WHAT IS CLAIMED IS:

1. An integrated circuit for testing using an e-beam tester comprising:

a ground grid;

a metal pad having a space therein and positioned within the ground grid; and

a metal line connected to the ground grid and positioned in the space.

2. The integrated circuit for testing using an e-beam tester as claimed in claim 1 wherein the metal line connected to the ground grid is a metal line that is positioned in the space and not electrically connected to the metal pad, whereby, upon the occurrence of an electrical short circuit between the metal line and the metal pad, the metal pad appears bright under the influence of the e-beam tester.

3. The integrated circuit for testing using an e-beam tester as claimed in claim 1 wherein the metal line connected to the ground grid is a metal line that is positioned within the space and electrically connected to the metal pad, whereby upon the occurrence of an electrical open circuit between the metal line and the metal pad, the metal pad appears dark under the influence of the e-beam tester.

4. The integrated circuit for testing using an e-beam tester as claimed in claim 1 wherein the metal line is a metal line of at least one of a T-shaped line, an obtuse-angled line, a right-angled line, a straight line, a serpentine line, an interleaved comb, and combinations thereof.

5. The integrated circuit for testing using an e-beam tester as claimed in claim 1 further comprising;

a second metal pad having a space therein positioned within the ground grid; and

a second metal line within the ground grid, wherein the second metal line is connected to the ground grid and positioned within the space.

6. An integrated circuit for testing using an e-beam tester comprising:

a ground grid;

a plurality of metal pads each having a space therein and positioned within the ground grid; and

a plurality of metal lines within the ground grid, wherein each of the plurality of metal lines is connected to the ground grid, associated with one of the plurality of

metal pads, and positioned within the space of its associated one of the plurality of metal pads.

7. The integrated circuit for testing using an e-beam tester as claimed in claim 6 wherein the plurality of metal lines within the ground grid comprises at least a portion of the plurality of metal lines that is not electrically connected to an associated metal pad, whereby, upon the occurrence of an electrical short circuit between a portion of the metal lines and the associated metal pad, the associated metal pad appears bright under the influence of the e-beam tester.

8. The integrated circuit for testing using an e-beam tester as claimed in claim 6 wherein the plurality of metal lines within the ground grid comprises at least a portion of the plurality of metal lines that is electrically connected to an associated metal pad, whereby upon the occurrence of an electrical open circuit between a portion of the metal lines and the associated metal pad, the associated metal pad appears dark under the influence of the e-beam tester.

9. The integrated circuit for testing using an e-beam tester as claimed in claim 6 wherein the plurality of metal lines is a plurality of metal lines of at least one of a T-shaped line, an obtuse-angled line, a right-angled line, a straight line, a serpentine line, an interleaved comb, and combinations thereof.

10. The integrated circuit for testing using an e-beam tester as claimed in claim 6 wherein at least a first portion of the plurality of metal lines is not electrically connected to their associated metal pads; and at least a second portion of the plurality of metal lines is electrically connected to their associated metal pads.