

A METHOD FOR DETECTING PROBING STRIPES

FIELD OF INVENTION

- 5 The invention relates to a method for detecting probing stripes during a wafer probing process through use of immediate re-probe data, data filtering and data maps or a detection program.

BACKGROUND

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In wafer manufacture, probing is a process for testing if dies formed on a wafer are functional. Probing dies on a wafer involves penetrating the surface of the wafer at predetermined points to make contact with the pads of each die. The probe uses probe needles to make contact with the pads of each die. Once the probe has penetrated the surface of the die an electronic signal is passed through the die from at least one probe
15 needle to at least one other probe needle. Information received from the probe needle(s) is used to determine the functionality of each die. A map is created for each wafer indicating the functionality patterns so formed.

- 20 Problems may arise in the probing process due to a number of different reasons. These reasons include dirt being trapped on the probing needles, surface residue building up on the probing needles, and the probing needles becoming bent out of shape.

- Product, yield or test engineers often wish to be able to know whether certain rejects on
25 a wafer are caused by the probing process or by the wafer itself. Probing stripes are patterns of probing results that change between the first probe and a re-probe. The presence of probing stripes may indicate a probing defect. Probing stripes appear when there are consecutive failures during the wafer probing process, caused by the movement of the probe which indexes from one die to the next, usually in either the
30 horizontal or the vertical direction. The probing stripes appear as lines on wafer map.

Using existing detection methods an operator must review the probe results and judge whether there is a probing process defect or a wafer defect by visually inspecting the failed wafer results or the low yield of certain results. For example, the operator may suspect that there is a probing issue if the number of failed dies per wafer gradually increases. Algorithms have been developed to assist in the detection and evaluation of stripes.

A disadvantage of known in the art methods is that probing problems may exist long before they are detected by the operator. This leads to the probing failure of potentially large numbers of dies that are good dies. Existing methods are slow and defects are often only detected once the stripes become severe. Visual inspection of wafer maps requires a large degree of engineering judgment causing uncertainty and inconsistency. Furthermore, algorithms are often too complex to be satisfactorily applied and sometimes cannot be applied at all.

The Applicant also has a related patent application filed as PCT/SG03/00022 over a Method for Detecting and Monitoring Wafer Probing Process Instability, the disclosure of which is incorporated herein in its entirety.

SUMMARY OF INVENTION

It is an object of this invention to provide a method for obtaining additional information for resolving low wafer test yields.

This and the following objects are objects of at least preferred embodiments of the present invention. It is not necessary for every embodiment to satisfy every stated object.

A further object of the invention is to overcome or at least ameliorate some of the aforementioned shortcomings of the prior art or to at least provide the public with a useful choice.

In broad terms in one aspect the invention comprises a method for detecting probing stripes including the steps of:

- probing a plurality of dies on a wafer;
- for each probed die determining whether the result of the probe is a pass or a
5 fail;
- if the result of the probe is a fail, re-probing the die and determining whether the
result of the re-probe is a pass or a fail;
- allocating the probe results of the dies to at least one bin;
- creating a wafer map for before re-probe data;
- 10 applying a filter to remove no bin switching dies from the wafer map; and
- visually detecting probing stripes.

In another aspect the invention comprises a method for detecting probing stripes including the steps of:

- 15 probing a plurality of dies on a wafer;
- for each probed die determining whether the result of the probe is a pass or a
fail;
- if the result of the probe is a fail, re-probing the die and determining whether the
result of the re-probe is a pass or a fail;
- 20 allocating the dies to at least one bin;
- applying a filter to remove no bin switching dies; and
- applying a detection program to detect probing stripes.

Preferably the bins are selected from the group comprising but not limited to: pass die
25 bins; fail die bins; switching die bins; no-switching die bins; and sensitive die bins.

Preferably the step of re-probing any die that fails on the first probe is preformed a
predetermined number of times. In one embodiment the re-probing is preformed only
once for each die that fails on the first probe. In alternative embodiments the step of re-
30 probing may be performed more than once.

Preferably the step of re-probing any die that fails on the first probe is performed immediately.

Desirably a filter is applied to remove dies that passed on the first probe.

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Optionally a filter is applied to remove known sensitive bin dies which exhibit behaviour independent of the location of any probing stripes.

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Preferably the detection program calculates the number of stripes found on a wafer and the severity (total length of all stripes $\div$ total number of dies). Preferably the detection program includes adjustable parameters such as, but not limited to, the minimum number of dies required to form a stripe, and the minimum number of no-switching bin dies allowed between two switching bin dies.

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Preferably the detection program processes data in a First In First Out (FIFO) manner.

Preferably the detection program counts any one or more of the following: the number of stripes detected; the number of dies tested; and the number of wafers tested.

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The entire method may be automated, generating reports identifying triggered wafers.

BRIEF DESCRIPTION OF DRAWINGS

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The invention including a preferred form thereof is described with reference to the accompanying drawings and without intending to be limiting, wherein:

Figure 1 is a normal completed wafer map;

Figure 2 is a before re-probe wafer map;

Figure 3 is a before re-probe wafer map with filtering of no-bin switching dies;

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Figure 4 is a before re-probe wafer map with no-bin switching and sensitive bins filters; and

Figure 5 is an after re-probe wafer map with no-bin switching and sensitive bins filters.

DETAILED DESCRIPTION

Probing stripes appear when there are consecutive failures during the wafer probing process. Probing stripes are typically caused by the movement of the probe which indexes from one die to the next, usually in either the horizontal or the vertical direction. The probing stripes appear as lines on the wafer map.

Figure 1 shows a completed wafer map with actual bin data, illustrating a normal map with rather scattered rejects. It is quite difficult to determine from Figure 1 whether there are probing stripes. As can be seen in Figure 1 each die is assigned a number. In the map shown in Figure 1 a '1' represents a die that has passed the probing process. The other numbers represent different failure bins of the probing process indicating different faults in the dies. Some types of probing failures may be more sensitive than others.

In a preferred embodiment the first stage of detecting probing stripes is to implement an immediate re-probe on die rejects after an initial probe during production wafer testing. An immediate re-probe has a better chance of bin switching a die to either a pass bin or to another failure bin compared to an end-of-wafer re-probe. Increased bin switching of dies means probing stripes are more prominent and visible.

Immediately re-probing has the further advantage that the die will be re-probed when it is still warm, which provides a better testing environment for the die. The immediate re-probe has a very low probe indexing time, which saves time in the re-probe as opposed to re-probing all dies that fail the initial probe after the whole wafer has been probed. Another advantage of the immediate re-probe is that once the probe holes have already been formed the probe can penetrate further into the wafer and establish better contact with the pads of the die.

In an alternative embodiment die rejects are not immediately re-probed but are re-probed at a later time.

All the before and after re-probe data is captured and stored in a database or file for processing and map plotting. Capturing of before and after re-probe data can be performed by various methods, including modifying the tester-prober driver; using the prober log file; post-processing the test data files using, for example, Standard Test Data Format (STDF) to extract out the die coordinates, bins and other information.

The next stage is to create a before re-probe wafer map from a set of before re-probe bin data. Figure 2 shows an example of a before re-probe wafer map. As illustrated by Figure 2 it is at this stage that the probing stripes start to appear.

Dies that exhibit no bin switching play very little role in promoting and making visible the probing stripes, and at this stage they can be excluded. This includes dies that pass on the first probe and dies that fail the re-probe in the same way as they failed the initial probe. Figure 3 is an example of a before re-probe map with a no-bin switching filter in place. For ease of reference, passing dies are represented by blank (white) rectangles and rejects are represented by outlined blank rectangles.

The probing stripes may be determined and their existence proven visually. Alternatively, an automated method of detecting the probing stripes may be employed.

In one embodiment known sensitive bins may be removed from the wafer map by a filter. Sometimes dies that fail the probing test are known sensitive bins crowded on the map, and such sensitive die behaviour may occur anywhere on the map irrespective of the relative position of probing stripes. It is therefore desirable to take out these dies as well by employing an additional filter.

Figure 4 is a wafer map with no-bin switching filtering and the optional sensitive bin filtering in place. The cross-hatched rectangles are the known sensitive bin dies.

Similarly an after re-probe wafer map can be plotted, as shown in Figure 5. Although this map is not used for probing stripes calculation, it assists in providing additional

information on the bin switching. The additional information that is provided on the wafer map includes information on the number of dies that switch from one bin failure to another bin upon reprobe and the location of dies that switch bins. For example the wafer map may show that the only dies that switched from bin 5 to bin 6 upon reprobe
 5 are located at one side of the wafer. This information may provides clues as to whether the bin failure is related to the fabrication process or not.

Probing stripes can also be detected automatically using a detection program.

- 10 The detection program can be in C-code or any suitable programming language inputs include the results of the probing process, the minimum number of die(s) required to make a stripe (the 'Minimum Length') and the minimum number of dies allowed between two bin-switching dies (the 'Tolerance').
- 15 The detection program receives probing information from the probing system and provides information on the results of the probing. For example the detection program may provide output indicating the total number of stripes found on a wafer and the ratio of the total length of stripes to the number of dies on the wafer. The detection program may also provide information on the location of probing stripes on the wafer and/or on
 20 the bin changes that form part of the probing stripes.

- As well as receiving probing stripe information from the probing system the detection program can be supplied with additional information. The additional information may include the minimum number of bin changing dies required for a stripe and the
 25 minimum number of dies allowed between two bin-changing dies within a stripe. This additional information may be provided with the probing information from the probing system. Alternatively, this information may be stored elsewhere and accessed by the detection program. Alternatively again the information may be provided by user entry. The additional information may be wafer specific so that different minimum numbers of
 30 dies in a stripe and different numbers of non switching dies within a stripe are applied to different wafers.

The detecting program detects the stripes according to the information provided. For example, where the minimum length of dies in a stripe is set at 5, a stripe must have at least 5 dies in sequence. Where the tolerance (the number of non bin-switching dies between two bin-switching dies) is set at 1 a stripe may contain no more than 1 non bin-switching die between any two bin-switching dies. For example, the sequence

5  is considered a stripe if the tolerance is set to 1. The blank die between the two 10 dies is a non bin-switching die. The length of this stripe is 7 which meets the minimum length of 5 above. If there are two dies in the gap instead of just one, the tolerance condition will not be met. In the example the number of dies in the

10 stripe will be four and will not meet the minimum number of dies for a stripe so no stripe will be detected. In preferred embodiments, the detection program will also count the number of stripes detected and the number of dies and/or wafers tested.

The additional information settings may be different from one product to another. In

15 preferred embodiments, statistical data is collected so that the additional parameters can be set at suitable levels according to the desired triggering level. The settings may be user defined, automatically set according to the wafer being probed or a default setting.

Typical information produced by the detection program includes the number of stripes

20 found on a wafer and the ratio of the Total Length of All Stripes / Total Dies. Other information may also be provided.

This technique is effective in targeting those wafers where there are several stripes on a map. Cases where there are large numbers of stripes and/or severity close to 100%, or

25 stripe patterns repeated on a few wafers, indicate there may be a severe probing issue or a real wafer process problem. Under these severe scenarios probing stripes detection will have little meaning.

Usually the movement of the wafer probing process is in sequential order from one side

30 of wafer to the other side of wafer, then in increments or decrements to the next row or column and the process is repeated. However, sometimes there may be a detour before reaching the end of the wafer due to reasons such as, but not limited to, manual

intervention by operator, or the probe is performing selected die probing. In such cases it is difficult to show these changes of route on a wafer map. The detection program can resolve such problems as it processes the data in a FIFO (first in, first out) manner rather than following the die coordinates.

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The method described above provides a fast, simple process for the early detection of wafer stripes in which wafer yield loss is minimised. The process is easily automated allowing product, yield or test engineers to view summary reports containing details of triggered wafers.

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The foregoing describes the invention including a preferred form thereof. Alterations and modifications are intended to be incorporated within the scope hereof as defined by the accompanying claims.

CLAIMS:

1. A method for detecting probing stripes including the steps of:
probing a plurality of dies on a wafer;
5 for each probed die determining whether the result of the probe is a pass or a fail;
if the result of the probe is a fail, re-probing the die and determining whether the
result of the re-probe is a pass or a fail;
allocating the probe results of the dies to at least one bin;
creating a wafer map for before re-probe data;
10 applying a filter to remove no bin switching dies from the wafer map; and
visually detecting probing stripes.
2. A method for detecting probing stripes as claimed in claim 1 wherein the bins are
selected from the group comprising but not limited to: pass die bins; fail die bins;
15 switching die bins; no-switching die bins; and sensitive die bins.
3. A method for detecting probing stripes as claimed in claim 1 wherein the step of
re-probing any die that fails on the first probe is performed a predetermined number of
times.
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4. A method for detecting probing stripes as claimed in claim 3 wherein re-probing
is performed only once for each die that fails on the first probe.
5. A method for detecting probing stripes as claimed in claim 3 wherein the step of
25 re-probing may be performed more than once.
6. A method for detecting probing stripes as claimed in claim 1 wherein the step of
re-probing any die that fails on the first probe is performed immediately.
- 30 7. A method for detecting probing stripes as claimed in claim 1 further including the
step of applying a filter to remove dies that passed on the first probe from the wafer
map.

8. A method for detecting probing stripes as claimed in claim 1 further including the step of applying a filter to remove known sensitive bin dies from the wafer map.

5 9. A method for detecting probing stripes as claimed in claim 7 wherein the known sensitive die bins exhibit behavior independent of the location of any probing stripes.

10. A method for detecting probing stripes including the steps of:

probing a plurality of dies on a wafer;

10 for each probed die recording whether the result of the probe is a pass or a fail;

if the result of the probe is a fail, re-probing the die and recording whether the result of the re-probe is a pass or a fail;

allocating the dies to at least one bin;

applying a detection program to the recorded data detect probing stripes; and

15 wherein no bin switching dies are not considered as components of a stripe.

11. A method for detecting probing stripes as claimed in claim 10 wherein the bins are selected from the group comprising but not limited to: pass die bins; fail die bins; switching die bins; no-switching die bins; and sensitive die bins.

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12. A method for detecting probing stripes as claimed in claim 10 wherein the step of re-probing any die that fails on the first probe is performed a predetermined number of times.

25 13. A method for detecting probing stripes as claimed in claim 12 wherein re-probing is performed only once for each die that fails on the first probe.

14. A method for detecting probing stripes as claimed in claim 12 wherein the step of re-probing may be performed more than once.

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15. A method for detecting probing stripes as claimed in claim 10 wherein the step of re-probing any die that fails on the first probe is performed immediately.

16. A method for detecting probing stripes as claimed in claim 10 wherein the detection program does not consider dies that passed on the first probe as components of a stripe.

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17. A method for detecting probing stripes as claimed in claim 10 wherein the detection program does not consider known sensitive bin dies as components of a stripe.

18. A method for detecting probing stripes as claimed in claim 17 wherein the known sensitive die bins exhibit behavior independent of the location of any probing stripes.

19. A method for detecting probing stripes as claimed in claim 10 wherein the detection program has inputs comprising but not limited to the results of the probing process, and adjustable parameters such as the minimum number of dies required to form a stripe, and the minimum number of no-switching bin dies allowed between two switching bin dies.

20. A method for detecting probing stripes as claimed in claim 10 wherein the detection program calculates:

the number of stripes found on a wafer; and
the severity according to the formula:

$$\text{Severity} = \text{Total Length of All Stripes} \div \text{Total Number of Dies.}$$

21. A method for detecting probing stripes as claimed in claim 10 wherein the detection program counts any one or more of the following: the number of stripes detected; the number of dies tested; and the number of wafers tested.

22. A method for detecting probing stripes as claimed in claim 10 wherein the detection program processes data in a First In First Out (FIFO) manner.

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23. A method for detecting probing stripes as claimed in claim 10 wherein the method is automated.

24. A method for detecting probing stripes as claimed in claim 22 wherein the automation provides for the generation of reports identifying triggered wafers.

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