

MEASURING APPARATUS AND METHOD

CROSS REFERENCE TO RELATED APPLICATION

This application claims the priority benefit of Taiwan Patent Application Serial Number 097117084, filed May 9, 2008, the full disclosure of which is incorporated herein by reference.

Background of the Invention

1 Field of the Invention

The present invention generally relates to a measuring apparatus, and more particularly to a measuring apparatus, which utilizes a top surface of the work-piece to be acted as a first measuring surface, and further utilizes a datum plane to replace a bottom surface of the work-piece and to be acted as a second measuring surface, wherein the datum plane and the top surface of the work-piece orient in the same direction.

2. Description of the Related Art

Currently, the shapes of the electronic products must be measured after electronic products are massively manufactured. For example, the thickness of the electronic product must be measured for judging whether the electronic product meets the requirement of standard size of the product or not. However, an inspector who works on the production line only uses a measuring tool, e.g. a vernier caliper or a separation ruler for measuring the thickness of the electronic product. Thus, this measuring manner does not conform to the efficiency of mass production extremely. Furthermore, there are a tool error and human operation error to happen when the inspector uses the measuring tool, e.g. the vernier caliper or the separation ruler.

Accordingly, there exists a need for measuring apparatus and method capable of solving the above-mentioned problems.

Summary of the Invention

It is an object of the present invention to provide a measuring apparatus, which utilizes a top surface of the work-piece to be acted as a first measuring surface, and further utilizes a datum plane to replace a bottom surface of the work-piece and to be acted as a second measuring surface, wherein the datum plane and the top surface of the work-piece orient in the

same direction, whereby the measuring apparatus can vastly, fast and correctly measures the thickness and the warp degree of the work-piece so as to conform to the efficiency of mass production.

In order to achieve the foregoing object, the present invention provides a measuring apparatus for measuring the thickness of at least one work-piece to be measured. The measuring apparatus includes a measuring fixture and a scanning device. The measuring fixture includes at least one carrier unit for accommodating the work-piece. The carrier unit includes a carrying cell and a datum plane. The carrying cell is adapted to carry the work-piece and has a carrying surface adapted to contact a bottom surface of the work-piece. The datum plane is outward extended from the carrying cell, the datum plane and a top surface of the work-piece orient in the same direction, there is a predetermined height difference between the datum plane and the carrying surface, and there is a measurable height difference formed between the top surface of the work-piece and the datum plane. The scanning device is adapted to scan the top surface of the work-piece and the datum plane so as to acquire the measurable height difference, whereby the thickness of the work-piece is calculated by the summation of the predetermined height difference and the measurable height difference.

Compared with the prior art, the present invention utilizes the top surface of the work-piece to be acted as a first measuring surface, and further utilizes the datum plane to replace the bottom surface of the work-piece and to be acted as a second measuring surface, wherein the datum plane and the top surface of the work-piece orient in the same direction. Thus, the measuring fixture and the scanning device of the present invention can vastly, fast and correctly measure the thickness and the warp degree of the work-piece (the work-piece can be electronic product, e.g. flash memory card, secure memory card, etc), whereby this measuring manner can conform to the efficiency of mass production.

The foregoing, as well as additional objects, features and advantages of the invention will be more apparent from the following detailed description, which proceeds with reference to the accompanying drawings.

Brief Description of the Drawings

FIG. 1 is a perspective view of a measuring apparatus according to an embodiment of the present invention.

FIG. 2 is a perspective view of a measuring fixture according to the embodiment of the present invention.

FIG. 3 is a cross-sectional view of a carrying unit according to the embodiment of the present invention.

FIG. 4 is a plan view of a carrying unit according to the embodiment of the present invention.

5 FIG. 5 is a cross-sectional view of a carrying unit according to the embodiment of the present invention, showing the height difference between the datum plane and the carrying surface is zero.

FIG. 6 is a cross-sectional view of a carrying unit and a scanning device according to the embodiment of the present invention.

10 FIG. 7 is a plan view of a carrying unit according to another embodiment of the present invention.

FIG. 8 is a plan view of a carrying unit according to a further embodiment of the present invention.

15 FIG. 9 is a flow diagram showing a measuring method according to an embodiment of the present invention.

Detailed Description of the Preferred Embodiment

Referring to FIG. 1, it depicts a measuring apparatus 110 for measuring the thickness of at least one work-piece 102 (e.g. flash memory card, secure memory card, etc) to be measured according to an embodiment of the present invention. A plurality of thickness values of a cross-section of the work-piece 102 can be formed to a warp degree, and thus the measuring apparatus 110 can measure the warp degree of the work-piece 102, too. The measuring apparatus 110 includes a measuring fixture 130 and a scanning device 120.

20 Referring to FIG. 2, a measuring fixture 130 includes at least one carrier unit 132 for accommodating the work-piece 102. In this embodiment, the measuring fixture 130 includes a plurality of carrier units 132, which are adapted to carry the work-pieces 102 and are arranged in rows and columns. The gap between adjacent two of the carrier units 132 must be more than 8 mm so as to prevent the scanning device 120 from wrong scanning the work-pieces 102 accommodated in different carrier units 132. Referring to FIG. 3, the carrier unit 132 includes a carrying cell 134 and two datum feet 136. The carrying cell 132 has a carrying surface 142 and two sides 146, wherein the carrying surface 142 is adapted to contact a bottom surface 106 of the work-piece 102, and the two sides 146 are physically connected to

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the carrying surface 142. One of the two datum feet 136 is mounted on one of the two sides 146, and the other one of the two datum feet 136 is mounted on the other one of the two sides 146. A top surface 138 of the datum foot 136 must have enough area so as to be easily scanned by the scanning device 120. The carrying cell 132 and the datum feet 136 can be integrally formed. The carrying cell 132 and the datum feet 136 can be made of metallic material, e.g. aluminum (Al) alloy. More detailed, the carrying cell 132 and the datum feet 136 can be made of Al alloy by technologies of computer-aided design (CAD), computer-aided manufacturing (CAM), computer numerical control (CNC) and high speed machining (HSM). Furthermore, the carrying cell 132 and the datum feet 136 can be made of plastic material, e.g. the carrying cell 132 and the datum feet 136 is made of plastic material by a plastic injection molding machine.

Referring to FIG. 4, the carrier unit 132 further includes a datum plane 139, which is outward extended from the carrying cell 134. The datum plane 139 and a top surface 104 of the work-piece 102 orient in the same direction. More detailed, according to the measuring manner in the prior art, the top surface 104 of the work-piece 102 is acted as a first measuring surface, the bottom surface 106 of the work-piece 102 is acted as a second measuring surface, and the top surface 104 and the bottom surface 106 of the work-piece 102 orient in opposite direction. However, according to the measuring fixture 130 of the present invention, the top surface 104 of the work-piece 102 is acted as a first measuring surface, and the datum plane 139 replaces the bottom surface 106 of the work-piece 102 and is acted as a second measuring surface, thereby vastly, fast and correctly measuring the work-piece 102.

Regarding each work-piece 102, the scanning device 120 is adapted to scan the top surface 104 of the work-piece 102 and any three points of the top surfaces 138 of the datum feet 136. The three points on the top surfaces 138 of the datum feet 136 forms a triangle for defining the datum plane 139. The datum plane 139 can covers a center of gravity of the work-piece 102, whereby the datum plane 139 can substantially covers the carrying surface 142. Referring to FIG. 3 again, there is a predetermined height difference (first height difference H1) between the datum plane 139 and the carrying surface 142, and there is a measurable height difference (second height difference H2) formed between the top surface 104 of the work-piece 102 and the datum plane 139, whereby the thickness T of the work-piece 102 is calculated by the summation of the first height difference H1 and the second height difference H2.

For example, work-pieces 102 to be measured are firstly disposed in the carrying cells 134 of the carrier units 132 of the measuring fixture 130 (shown in FIG. 2), and the measuring fixture 130 is mounted on a measuring platform 112 (shown in FIG. 1). Then, the measuring platform 112 or the scanning device 120 is moved by a driving device (not shown), whereby each work-piece 102 is conveyed to a position located under the scanning device 120. Then, the top surface 104 of each work-piece 102 is scanned, and any three points of the top surfaces 138 of the datum feet 136 are scanned for defining the datum plane 139 (shown in FIG. 4). Finally, scanned signals are transmitted to a computer for calculating the height of the top surface 104 of the work-piece 102 and the height of the datum plane 139, whereby the thickness T of the work-piece 102 is calculated by the summation of the first height difference $H1$ and the second height difference $H2$ (shown in FIG. 3). Preferably, if the datum plane 139 and the carrying surface 142 have the same height, the height difference between the datum plane 139 and the carrying surface 142 is zero, i.e. the thickness T of the work-piece 102 is the height difference $H2$ between the top surface 104 of the work-piece 102 and the datum plane 139 (shown in FIG. 5).

Referring to FIG. 6, a pickup head 122 of the scanning device 120 includes a transmitter 124 and a receiver 126. The scan manner of the scanning device 120 is to utilize the transmitter 124 which transmits signals to the work-piece 102 and the receiver 126 which receives the feedback strength and time of the reflected signals for calculating the height of the top surface 104 of each work-piece 102 and the height of the datum plane 139. The signals transmitted by the transmitter 124 can be laser beams, optical beams, infrared rays or ultrasonic waves. In this embodiment, as the laser beams or the optical beams transmitted by the transmitter 124 are limited to the design of the scanning device 120 and the scattering of the laser beams or the optical beams, the angle θ between a transmitting direction of the transmitter 124 and the receiving direction of the receiver 126 must be more than 20 degrees. If the datum foot 136 of the carrier units 132 of the measuring fixture 130 has an L-shaped cross-section, the angle between a first inner surface $S1$ and a second inner surface $S2$ of the L-shaped cross-section must be equal to 90 degrees plus a leading angle "A" which is more than 20 degrees, whereby the receiver 126 effectively receives the feedback strength and time of the reflected signals (e.g. the laser beams or the optical beams).

Referring to FIG. 7, in another embodiment, the carrier unit 132 includes six datum feet 136, wherein three of the six datum feet 136 are mounted on one of the two sides 146, and the other ones of the six datum feet 136 are mounted on the other one of the two sides 146. Two

sets of three points (i.e. six points) on the top surfaces 138 of the datum feet 136 forms two triangles for defining two datum planes 139. Both of the datum planes 139 cover a center of gravity of the work-piece 102. The two datum planes 139 form a mean datum plane 139', and there is a measurable height difference (third height difference H3) formed between the top surface 104 of the work-piece 102 and the mean datum plane 139', whereby the thickness T of the work-piece 102 is calculated by the summation of the first height difference H1 and the third height difference H3 (shown in FIG. 3). The datum planes 139 on the top surfaces 138 of the datum feet 136 can improvably solve the problem of possibly failing measurement (i.e. erroneous measurement) because of only one datum plane.

Referring to FIG. 8, in a further embodiment, the carrier unit 132 includes ten datum feet 136, wherein five of the ten datum feet 136 are mounted on one of the two sides 146, and the other ones of the ten datum feet 136 are mounted on the other one of the two sides 146. At least three sets of three points (i.e. at least nine points), e.g. six sets of three points (i.e. eighteen points) on the top surfaces 138 of the datum feet 136 define six datum planes. All of the datum planes cover a center of gravity of the work-piece 102. The datum planes form a mean datum plane, and there is a measurable height difference (fourth height difference H4) formed between the top surface 104 of the work-piece 102 and the mean datum plane, whereby the thickness T of the work-piece 102 is calculated by the summation of the first height difference H1 and the fourth height difference H4 (shown in FIG. 3). As the amount of datum planes are increased, at least three datum planes (e.g. six datum planes) on the top surfaces 138 of the datum feet 136 can improvably solve the problem of possibly failing measurement because of only two datum planes. The gaps between adjacent two of the datum feet 136 located on the same side must be more than 1 mm so as to prevent the datum feet 136 from hard manufacture. Preferably, the gap between the adjacent two of the datum feet 136 located on the same side is between 1 mm and 2 mm, and the heights of the datum feet 136 are more than at least 1 mm.

Compared with the prior art, the present invention utilizes the top surface of the work-piece to be acted as a first measuring surface, and further utilizes the datum plane to replace the bottom surface of the work-piece and to be acted as a second measuring surface, wherein the datum plane and the top surface of the work-piece orient in the same direction. Thus, the measuring fixture and the scanning device of the present invention can vastly, fast and correctly measure the thickness and the warp degree of the work-piece (the work-pieces

can be electronic products, e.g. flash memory card, secure memory card, etc), whereby this measuring manner can conform to the efficiency of mass production.

Referring to FIG. 9, it depicts a measuring method using the measuring fixture of the present invention. First, a measuring fixture is provided, wherein the measuring fixture includes at least one carrier unit, the carrier unit includes a carrying cell and a datum plane, the carrying cell has a carrying surface, the datum plane is outward extended from the carrying cell, and there is a predetermined height difference between the datum plane and the carrying surface. Then, at least one work-piece is disposed in the carrying cell, wherein the carrying surface contacts a bottom surface of the work-piece, the datum plane and a top surface of the work-piece orient in the same direction, and there is a measurable height difference formed between the top surface of the work-piece and the datum plane. Then, the datum plane and the top surface of the work-piece are scanned so as to acquire the measurable height difference. Finally, the thickness of the work-piece is calculated by the summation of the predetermined height difference and the measurable height difference. Preferably, if the datum plane and the carrying surface have the same height, the height difference between the datum plane and the carrying surface is zero, i.e. the thickness of the work-piece is the height difference between the top surface of the work-piece and the datum plane.

The carrying cell further has two sides, which are physically connected to the carrying surface. The carrier unit further includes two datum feet. One of the two datum feet is mounted on one of the two sides, and the other one of the two datum feet is mounted on the other one of the two sides. Furthermore, any three points on top surfaces of the datum feet are scanned so as to define the datum plane by using a scanning device.

Although the invention has been explained in relation to its preferred embodiment, it is not used to limit the invention. It is to be understood that many other possible modifications and variations can be made by those skilled in the art without departing from the spirit and scope of the invention as hereinafter claimed.

What is claimed is:

1. A measuring fixture comprising at least one carrier unit for accommodating at least one work-piece to be measured, the carrier unit comprising:

5 a carrying cell being adapted to carry the work-piece and having a carrying surface adapted to contact a bottom surface of the work-piece; and

10 a datum plane outward extended from the carrying cell, wherein the datum plane and a top surface of the work-piece orient in the same direction, there is a predetermined height difference between the datum plane and the carrying surface, and there is a measurable height difference formed between the top surface of the work-piece and the datum plane, whereby the thickness of the work-piece is calculated by the summation of the predetermined height difference and the measurable height difference.

- 15 2. The measuring fixture as claimed in claim 1, wherein the carrying cell further has two sides physically connected to the carrying surface, the carrier unit further comprises two datum feet, one of the two datum feet is mounted on one of the two sides, the other one of the two datum feet is mounted on the other one of the two sides, and the datum plane is defined by any three points on top surfaces of the datum feet.

3. The measuring fixture as claimed in claim 1, wherein the predetermined height difference is zero.

- 20 4. The measuring fixture as claimed in claim 1, wherein the datum plane covers a center of gravity of the work-piece.

- 25 5. The measuring fixture as claimed in claim 1, wherein the carrying cell further has two sides physically connected to the carrying surface, the carrier unit further comprises six datum feet, three of the six datum feet are mounted on one of the two sides, the other ones of the six datum feet are mounted on the other one of the two sides, the datum plane is defined by six points on top surfaces of the datum feet, and the datum plane covers a center of gravity of the work-piece.

6. The measuring fixture as claimed in claim 5, wherein the gaps between adjacent two of the datum feet located on the same side are more than 1 mm.

- 30 7. The measuring fixture as claimed in claim 1, wherein the measuring fixture comprises a plurality of carrier units arranged in rows and columns.

8. A measuring apparatus for measuring the thickness of at least one work-piece to be measured, the measuring apparatus comprising:

a measuring fixture comprising at least one carrier unit for accommodating the work-piece, the carrier unit comprising:

5 a carrying cell being adapted to carry the work-piece and having a carrying surface adapted to contact a bottom surface of the work-piece; and

a datum plane outward extended from the carrying cell, wherein the datum plane and a top surface of the work-piece orient in the same direction, there is a predetermined height difference between the datum plane and the carrying surface,
10 and there is a measurable height difference formed between the top surface of the work-piece and the datum plane; and

a scanning device adapted to scan the top surface of the work-piece and the datum plane so as to acquire the measurable height difference, whereby the thickness of the work-piece is calculated by the summation of the predetermined height difference and the
15 measurable height difference.

9. The measuring apparatus as claimed in claim 8, wherein the carrying cell further has two sides physically connected to the carrying surface, the carrier unit further comprises two datum feet, one of the two datum feet is mounted on one of the two sides, the other one of the two datum feet is mounted on the other one of the two sides, and the datum plane is
20 defined by any three points on top surfaces of the datum feet, wherein the datum foot has an L-shaped cross-section, and an angle between a first inner surface and a second inner surface of the L-shaped cross-section is equal to 90 degrees plus a leading angle being more than 20 degrees.

10. The measuring apparatus as claimed in claim 8, wherein the carrying cell further has two
25 sides physically connected to the carrying surface, the carrier unit further comprises six datum feet, three of the six datum feet are mounted on one of the two sides, the other ones of the six datum feet are mounted on the other one of the two sides, the datum plane is defined by six points on top surfaces of the datum feet, and the datum plane covers a center of gravity of the work-piece.

30 11. The measuring apparatus as claimed in claim 9, wherein the heights of the datum feet are more than at least 1 mm.

12. The measuring apparatus as claimed in claim 8, wherein the measuring fixture comprises a plurality of carrier units arranged in rows and columns.

13. A measuring method comprising the following steps of:

5 providing a measuring fixture, wherein the measuring fixture comprises at least one carrier unit, the carrier unit comprises a carrying cell and a datum plane, the carrying cell has a carrying surface, the datum plane is outward extended from the carrying cell, there is a predetermined height difference between the datum plane and the carrying surface;

10 disposing at least one work-piece in the carrying cell, wherein the carrying surface contacts a bottom surface of the work-piece, the datum plane and a top surface of the work-piece orient in the same direction, and there is a measurable height difference formed between the top surface of the work-piece and the datum plane;

scanning the datum plane and the top surface of the work-piece so as to acquire the measurable height difference; and

15 calculating the thickness of the work-piece by the summation of the predetermined height difference and the measurable height difference.

20 14. The measuring method as claimed in claim 13, wherein the carrying cell further has two sides physically connected to the carrying surface, the carrier unit further comprises two datum feet, one of the two datum feet is mounted on one of the two sides, the other one of the two datum feet is mounted on the other one of the two sides, and any three points on top surfaces of the datum feet are scanned so as to define the datum plane by using a scanning device.