Description

BACKGROUND OF THE INVENTION

This invention relates to a moldable plastic wafer carrier or basket for silicon wafers which are designed for the transportation, storage and processing of silicon wafers used in the production of integrated circuit chips.

The processing of wafers towards integrated circuit chips requires that they be successively immersed, sprayed and/or rinsed with liquids or gases. Some of the chemical baths include various corrosive chemicals while certain of the baths are extremely hot, in the range of 180°C. Wafers that are presently being processed have diameters as large as 20 cm (eight inches).

It should be recognized that silicon wafers are extremely delicate and brittle and may be only a few thousandths of an inch thick. The silicon wafers are extremely valuable and breakage of a wafer may represent a significant loss. Particulate and other contamination of wafers must also be avoided in order to manufacture integrated circuit chips operable within the range of standards set by the industry. Thus, there has been an increase in automated handling of the silicon wafers 5 axially aligned in batches supported in wafer carriers or baskets 10. Vacuum wands or fingers 57 are Being utilized for handling individual silicon wafers after the carrier 10 is indexed, elevated and supported by wafer transfer equipment or devices 51. Robotic arms are also used for transporting the carrier 10 from station to station.

Typically, twenty-five of such wafers 5 are within a single wafer basket or carrier 10 which requires that a carrier be large enough for this capacity. Such a carrier, which is full of wafers, will easily weigh 3.6 - 4.5 kg (eight to 10 pounds).

Two Hundred millimeter (200 mm) wafers are also now being used and will be in common use in the foreseeable future. Wafer carriers typically used to hold the silicon wafers are often conveniently formed of moldable plastic such as polypropylene, polyetheretherketone, PFA Teflon® (a registered trademark of E. I du Pont Nemours company of Wilmington, Delaware), perfluoroalkoxy-substituted polytetrafluoroethylene resin or other suitable plastics which are suitably inert, do not have significant out gasing characteristics, and will not corrode.

More specifically referring to FIGS. 1-4, the silicon wafers 5 may be seen within a wafer carrier 10 and in conjunction with known silicon wafer transfer equipment and devices 51 and 57. Wafer carriers 10 are disclosed in more detail in co-owned U.S. Patent No. 4,949,848 issued on August 21, 1990 and cited references therein. Carrier 10 includes an open top 11, open bottom 12, upright sidewalls 13 with opposing lower wall portions 14 offset inwardly. Sidewalls 13 may include windows, cutaways or wash slots 16 along with opposing and inwardly projecting ribs 18 which have appropriately twenty-five wafer pockets or slots 19^1 - 19^{25} therebetween. Foot panels 20 join the lower wall portions 14 and support the carrier 10 when in its upright position. The top surfaces 22 of foot panels 20 support the wafers 5 within the carrier 10. At the top of sidewalls 13 are located flanges 28.

Carrier 10 has an H-shaped end wall 40 suitably with an H-shaped flange 42 which supports and adds strength to a horizontal indexing bar 44. When carrier 10 is stpod on its H-shaped end wall 40, it is supported by H-bar contact rails or struts 45 each of which may have a robot pickup flange 46 and a contact surface 48. Some carriers may have machined nubs, knobs, or pads 49 on the contact surface 48. Carrier 10 also has an opposing end wall 50 opposite H-shaped end wall 40.

As stated, carrier 10 may be stood on its H-shaped end wall 40 with the indexing bar 44 used for properly indexing the carrier 10 on an elevator or a wafer transfer equipment device 51. The wafer transfer device 51 has a vertically movable positioning platform or plate 53 with carrier indexing positioners or webbing 55 thereon. By this arrangement, the indexing bar 44 may be properly located within the positioners 55 and the carrier 10 elevated upwardly or downwardly to position individual wafers 10 in front of a wafer removal or transfer device, such as a vacuum wand or finger 57. There are other end wall configurations for indexing but H-shaped end wall 40 is most common.

Due to the numbers of manufacturers of silicon wafers, wafer carriers, wafer transfer equipment, wafer processing chemicals and equipment, and integrated circuit chips, Semiconductor Equipment and Materials Institute, Inc. (SEMI) was formed and is located in Mountain View, California 94043. SEMI, with industry participation, has set specifications and standards for wafers, carriers and equipment configurations. According to the SEMI standards, D1 is the tolerable distance from the contact surface 48 of the H-bar contact rails 45 to the centerline C_L of the first wafer pocket 19^1. Illustratively, D1 for a 150 mm (5.91 inches) carrier should be 14.54 mm ± .13 mm (.5725 inches ± .005 inches). With respect to the wafer 5 and the first pocket 19^1, the bottom edge of the wafer or the wafer plane W_p-H must be .89 mm +/- .635 mm (.035 inches ± .025 inches) from the pocket centerline C_L. Manufacturers of semiconductor processing materials and equipment who stay within these standards find that their materials and equipment are acceptable among wafer processors in that the silicon wafers 5 within carriers 10 are in predictable locations for suitable handling by processing equipment and devices 51 and 57.

When a wafer carrier 10 is molded or formed out of a plastic, such as PFA Teflon®, the carrier during

its molding, curing and setting up process is subject to forces and stresses due to the molten plastic location and associated shrinking forces which typically result in some degree of carrier warpage and/or shrinkage. consequently, the carrier manufacturing industry has been required to have a narrow window of acceptable molding process parameters including temperature, pressure and time in an effort to minimize carrier warpage and shrinkage and to maintain strict industry and/or SEMI wafer carrier standards.

Depending upon the particular configuration and plastic material, many molded carriers experience shrinkage and warpage to a degree that they are unfit for use and are rejected. Rejection of some carrier configurations difficult to mold maybe in a range of up to 50 percent. Rejection may occur when the particular carrier does not fit within the SEMI standards, experiences a "rocking chair" effect in that it does not sit steadily flat upon the wafer transfer equipment 51, or experiences a wafer tilt. Water tilt means that the wafers are not oriented true to horizontal but rather may have their top edges, when in the indexed carrier, tilted downwardly. Equipment access to wafers in this condition often results in breakage and contamination.

There is a need for a moldable plastic wafer carrier with a wide window of acceptable molding process parameters. Such a carrier should readily compensate for the stresses and forces which result in carrier warpage and shrinkage during its formation. The carrier should compensate for wafer tilting and should not rock when standing on its H-shaped end wall. Although some warpage and shrinking may be inevitable, the carrier should have compensating features which are not susceptible to the deleterious effects of warpage and shrinking. The carrier should be predictably and steadfastly locatable upon wafer transfer equipment as its supports and carriers wafers. Finally, such a carrier should not be subject to a measurable range of rejection due to nonconformance with industry accepted standards and SEMI specifications.

SUMMARY OF THE INVENTION

A moldable plastic carrier for predictably and steadfastly locating the carrier and wafers therein upon wafer transfer equipment has an opening for insertion and removal of the wafers, a pair of opposed upright sidewalls with inner opposed ribs and wafer pockets therebetween for spacing and supporting the axially aligned wafers in the carrier. The carrier has a pair of opposed upright end walls with one upright end wall being indexable upon the transfer equipment. The one end wall has opposing transfer equipment contact rails each with first and second portions. An arch due to a ramp is between the first and second portions thereby forming a 4-point contact with the transfer equipment.

A principal object and advantage of the present invention is that the wafer carrier has a wider window of acceptable molding process parameters than heretofore known.

Another object and advantage is that the present invention readily conforms to the SEMI standards, compensates for the occurrence of wafer tilt and is not easily subject to the deleterious effects of warpage and shrinkage as to interfere with its usage in storing, transporting and processing of silicon wafers.

Another object and advantage of the present invention is that it predictably and steadfastly permits location of the carrier and wafers therein upon the wafer transfer equipment without rocking to minimize wafer damage and loss and to maximize processed silicon wafer and integrated circuit chip yields.

All these objects and advantages are realized by strategically locating only a small amount of plastic material on the molded carrier. It is important to note that a small amount of material is not as susceptible to warpage or shrinkage as is a large amount of plastic material.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a prior art wafer carrier with several silicon wafers therein;
FIG. 2 is a broken away end view of the prior art carrier of FIG. 1 taken along lines 2-2 of FIG. 1 with the carrier resting on its H-shaped end wall;
Fig. 3 is a side elevational view of the wafer carrier upon a wafer transfer device;
FIG. 4 is a top plan view of the vertically movable platform of the wafer transfer device showing the prior art carriers' and the present invention's places of contact with the device;
FIG. 5 is a front elevational view of the present carrier with improved contact H-bar rails;
FIG. 6 is a broken away cross-sectional view taken along lines 6-6 of FIG. 5; and
FIG. 7 is a side elevational view of the present carrier indexed upon the vertically movable positioning platform or plate of a wafer transfer device.

DETAILED DESCRIPTION

Referring to FIGS. 5-7, the improved wafer carrier 58 may be seen. Similar to the prior art wafer carrier 10, the present carrier 58 preferably may include an opening 11 for insertion and removal of wafers, an open bottom 12, sidewalls 13, offset wall portions 14, wash slots 16, ribs 18, wafer pockets 19^{1-25}, foot panels 20 with wafer support surfaces 22, flanges 28 and end wall 50.

The improved carrier 58 has end wall contact rails or struts 59 located at H-shaped end wall 60. Other

end wall configurations are suitable for this invention. The rails 59 are substantially flat, opposing, parallel and mirror images of each other. The rails 59 have outwardly projecting robotic pickup flanges 61. On the front side of rails 59 are located contact surfaces 63 which have an inner edge 65 and an outer edge 67. There is a rearward slope or draft from the inner edge 65 to the outer edge 67 which appropriately may be approximately 2° as represented by angle B which puts the inner edge 65 of surface 63 forwardmost. The contact surfaces 63 of rails 59 each have an upper portion 69 and a lower portion 71.

On the upper portion 69 of the contact surface 63 of each rail 59 is located a raised ramp, incline or arch 73 of plastic material which is molded into the carrier 58 preferably located along inner edge 65. Illustratively and not restrictively stating, the ramp 73 suitably may be 3.8 cm (1.5 inches) long, 0.15 cm (.06 inches) wide, and 0.046 cm (.018 inches) high at its beginning on the upper portion 69. As shown in FIG.7, the gap A formed by arch or ramp 73 intermediate the upper portion 69 and lower portion 71 measures approximatively 0.038 cm (.015 inches). By this arrangement, carrier 58 has four points of contact 75 and 77 on end wall 60 with whatever it is indexed or set upon.

The illustrative dimensions of the ramp 73 along the upper portion 69 of contact surface 63 and inner edge 65 are quite noticeably nominal with respect to the overall carrier 58. In other words, the amount of plastic material required for ramp 73 is relatively small. It is known that molded plastic materials are subject to more stresses and forces of warpage and shrinkage when the material is in larger amounts versus smaller amounts. The present ramp 73 takes advantage of this phenomenon. The four point contacts 75 and 77 of carrier 58 are not so readily susceptible to warpage and shrinkage with respect to each other. Consequently, carrier 58 is not likely to experience the rocking chair effect and will steadily sit on any surface. Utilizing the more massive entire contact surface 48, which is more so susceptible to warpage and shrinking, renders the prior art carriers 10 more susceptible to the rocking chair effect.

The dimensions of the ramp 73 may vary depending upon the carrier configuration and the plastic material from which the carrier 58 is molded. The configuration of the carrier 58 becomes a factor to ramp 73 dimensions by virtue of the location and mass of the plastic with respect to various walls and components of the carrier. Where one carrier has more plastic in some areas and less plastic in other areas, the forces and stresses that the carrier undergoes during it molding, curing and setting up varies from one carrier to another. This results in different shrinkage and warpage depending upon the carrier configuration. Consequently, the ramp 73 may be of a larger or smaller dimensions depending upon carrier configuration. Similarly, the shrinking and warping characteristics of the plastic material from which the carrier is molded may effect ramp 73 dimensions.

Considering these factors, the ramp, incline or arch 73, has been found to vary in height from a range from 0.025 cm to 0.050 cm (.010 to .020 inches) depending upon the particular carrier material and configuration. The length of the ramp 73 may be appropriate to smoothly blend the ramp 73 into the contact surface 63 as to minimize fluids from clinging to the carrier. Also by this arrangement, contact point 75 of the ramp 73 and not the entire length of the ramp 73 is contacting the equipment 51. The small degree of draft or slope advantageously creates point contact 75 and 77 rather than supporting carrier 58 along any edge which is more susceptible to warpage and shrinking.

By having four contact surfaces 75 and 77 versus a full contact rail surface 48, as shown in FIG 4, the carrier will acceptably allow some rail 59 warpage, even between contact points 75 and 77, but yet will not experience the rocking chair effect. Further still, the present carrier 58 by virtue of its tolerance for shrinkage and warpage may be process molded in a wider window of acceptable parameters including temperature, pressure and time while yet remaining within the SEMI and industry standards and specifications previously discussed.

The present invention may be embodied in other forms; therefore, the illustrated embodiments, particularly the specified dimensions of ramp 73, should be considered in all respects as illustrative and not restrictive, reference being made to the appended claims rather than to the foregoing description to indicate the scope of the invention.

Claims

1. A moldable plastic carrier (58) for locating the carrier and wafers therein upon wafer transfer equipment, said carrier having an opening (11) for insertion and removal of wafers, said opening being formed by a pair of opposed sidewalls (13) with inner opposed ribs (18) and wafer pockets (19) therebetween for spacing and supporting the axially aligned wafers in the carrier and a pair of end walls (60,50), the first end wall (60) being indexable upon the transfer equipment and said first end wall being comprised of opposing transfer equipment contact rails (59) each with first (69) and second (71) portions and being substantially flat, said contact rails each having an inner edge (65) toward said opening and an outer edge (67) away from said opening, said rails sloping away from said first end wall from said inner edge to said outer edge, and a raised ramp (73) beginning at said first portion of each of said contact

end wall configurations are suitable for this invention. The rails 59 are substantially flat, opposing, parallel and mirror images of each other. The rails 59 have outwardly projecting robotic pickup flanges 61. On the front side of rails 59 are located contact surfaces 63 which have an inner edge 65 and an outer edge 67. There is a rearward slope or draft from the inner edge 65 to the outer edge 67 which appropriately may be approximately 2° as represented by angle B which puts the inner edge 65 of surface 63 forwardmost. The contact surfaces 63 of rails 59 each have an upper portion 69 and a lower portion 71.

On the upper portion 69 of the contact surface 63 of each rail 59 is located a raised ramp, incline or arch 73 of plastic material which is molded into the carrier 58 preferably located along inner edge 65. Illustratively and not restrictively stating, the ramp 73 suitably may be 3.8 cm (1.5 inches) long, 0.15 cm (.06 inches) wide, and 0.046 cm (.018 inches) high at its beginning on the upper portion 69. As shown in FIG.7, the gap A formed by arch or ramp 73 intermediate the upper portion 69 and lower portion 71 measures approximatively 0.038 cm (.015 inches). By this arrangement, carrier 58 has four points of contact 75 and 77 on end wall 60 with whatever it is indexed or set upon.

The illustrative dimensions of the ramp 73 along the upper portion 69 of contact surface 63 and inner edge 65 are quite noticeably nominal with respect to the overall carrier 58. In other words, the amount of plastic material required for ramp 73 is relatively small. It is known that molded plastic materials are subject to more stresses and forces of warpage and shrinkage when the material is in larger amounts versus smaller amounts. The present ramp 73 takes advantage of this phenomenon. The four point contacts 75 and 77 of carrier 58 are not so readily susceptible to warpage and shrinkage with respect to each other. Consequently, carrier 58 is not likely to experience the rocking chair effect and will steadily sit on any surface. Utilizing the more massive entire contact surface 48, which is more so susceptible to warpage and shrinking, renders the prior art carriers 10 more susceptible to the rocking chair effect.

The dimensions of the ramp 73 may vary depending upon the carrier configuration and the plastic material from which the carrier 58 is molded. The configuration of the carrier 58 becomes a factor to ramp 73 dimensions by virtue of the location and mass of the plastic with respect to various walls and components of the carrier. Where one carrier has more plastic in some areas and less plastic in other areas, the forces and stresses that the carrier undergoes during it molding, curing and setting up varies from one carrier to another. This results in different shrinkage and warpage depending upon the carrier configuration. Consequently, the ramp 73 may be of a larger or smaller dimensions depending upon carrier configuration. Similarly, the shrinking and warping characteristics of the plastic material from which the carrier is molded may effect ramp 73 dimensions.

Considering these factors, the ramp, incline or arch 73, has been found to vary in height from a range from 0.025 cm to 0.050 cm (.010 to .020 inches) depending upon the particular carrier material and configuration. The length of the ramp 73 may be appropriate to smoothly blend the ramp 73 into the contact surface 63 as to minimize fluids from clinging to the carrier. Also by this arrangement, contact point 75 of the ramp 73 and not the entire length of the ramp 73 is contacting the equipment 51. The small degree of draft or slope advantageously creates point contact 75 and 77 rather than supporting carrier 58 along any edge which is more susceptible to warpage and shrinking.

By having four contact surfaces 75 and 77 versus a full contact rail surface 48, as shown in FIG 4, the carrier will acceptably allow some rail 59 warpage, even between contact points 75 and 77, but yet will not experience the rocking chair effect. Further still, the present carrier 58 by virtue of its tolerance for shrinkage and warpage may be process molded in a wider window of acceptable parameters including temperature, pressure and time while yet remaining within the SEMI and industry standards and specifications previously discussed.

The present invention may be embodied in other forms; therefore, the illustrated embodiments, particularly the specified dimensions of ramp 73, should be considered in all respects as illustrative and not restrictive, reference being made to the appended claims rather than to the foregoing description to indicate the scope of the invention.

Claims

1. A moldable plastic carrier (58) for locating the carrier and wafers therein upon wafer transfer equipment, said carrier having an opening (11) for insertion and removal of wafers, said opening being formed by a pair of opposed sidewalls (13) with inner opposed ribs (18) and wafer pockets (19) therebetween for spacing and supporting the axially aligned wafers in the carrier and a pair of end walls (60,50), the first end wall (60) being indexable upon the transfer equipment and said first end wall being comprised of opposing transfer equipment contact rails (59) each with first (69) and second (71) portions and being substantially flat, said contact rails each having an inner edge (65) toward said opening and an outer edge (67) away from said opening, said rails sloping away from said first end wall from said inner edge to said outer edge, and a raised ramp (73) beginning at said first portion of each of said contact

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rails and extending to a point intermediate of the first and second portions of said contact rails thereby forming four points of contact between the carrier and the equipment with two points of contact at the beginning of the ramps and the other two points of contact at the inner edge of said second portions.

2. The carrier of claim 1, wherein the first end wall is H-shaped with an H-shaped flange and a horizontal indexing bar between the rails.

3. The carrier of claim 1, further comprising a robotic pick-up flange on the outside of the first portion of each rail.

4. The carrier of claim 1, wherein the ramp becomes flush with the rail at the intermediate of the first and second portions.

5. The carrier of claim 4, wherein the ramp is in a range of 0.025 cm to 0.050 cm (.010 to .020 inches) high and extends to the lower portion between one and two inches.

6. The carrier of claim 4, wherein the ramp is approximately 0.15 cm (.06 inches) wide.

7. The carrier of claim 5, wherein the ramp is approximately 0,046 cm (.018 inches) high.

Patentansprüche

1. Kunststofformträger (58) zum Anordnen des Trägers und von Wafern darin auf einer Wafertransportvorrichtung, wobei der Träger eine Öffnung (11) zum Einsetzen und Entfernen von Wafern hat, wobei die Öffnung durch ein Paar gegenüberliegender Seitenwände (13) mit inneren gegenüberliegenden Rippen (18) und Wafertaschen (19) dazwischen, um die axial ausgerichteten Wafer im Träger beabstandet anzuordnen und zu halten, und ein Paar von Endwänden (60,50) ausgebildet ist, wobei die erste Endwand (60) an der Transportvorrichtung einrastbar ist und wobei die erste Endwand gegenüberliegende Transportvorrichtung-Kontaktschienen (59) aufweist, die jeweils erste (69) und zweite (71) Abschnitte haben und im wesentlichen flach sind, wobei die Kontaktschienen jeweils eine Innenkante (65) zu der Öffnung hin und eine Außenkante (67) von der Öffnung weg haben, wobei die Schienen von der ersten Endwand von der Innenkante zu der Außenkante abfallen, und eine hervorstehende Rampe (73) haben, die an dem ersten Abschnitt jeder der Kontaktschienen anfängt und sich zu einem Punkt zwischen den ersten und zweiten Abschnitten der Kontaktschienen erstreckt, wodurch vier Kontaktpunkte zwischen dem Träger und der Vorrichtung gebildet werden, wobei zwei Kontaktpunkte am Anfang der Rampen und die anderen zwei Kontaktpunkte an der Innenkante der zweiten Abschnitte sind.

2. Träger nach Anspruch 1, worin die erste Endwand H-förmig mit einem H-förmigen Flansch und einem horizontalen Einrastbalken zwischen den Schienen ist.

3. Träger nach Anspruch 1, der des weiteren einen automatischen Aufnahmeflansch an der Außenseite des ersten Abschnitts jeder Schiene aufweist.

4. Träger nach Anspruch 1, worin die Rampe bündig mit der Schiene an dem Punkt zwischen den ersten und zweiten Abschnitten wird.

5. Träger nach Anspruch 4, worin die Rampe in einem Bereich von 0,025 cm bis 0,050 cm (0,010 bis 0,020 Inches) hoch ist und sich zum unteren Abschnitt zwischen einem und zwei Inches erstreckt.

6. Träger nach Anspruch 4, worin die Rampe ungefähr 0,15 cm (0,06 Inches) breit ist.

7. Träger nach Anspruch 5, worin die Rampe ungefähr 0,046 cm (0,018 Inches) hoch ist.

Revendications

1. Support (58) pouvant être moulé en matière plastique, permettant de positionner le support et des tranches qu'il contient sur une machine de transfert de tranches, ledit support présentant une ouverture (11) pour l'insertion et l'enlèvement de tranches, ladite ouverture étant formée par deux parois latérales opposées (13) comportant des nervures intérieures opposées (18) et, entre elles, des logements (19) de tranches pour écarter et supporter les tranches alignées axialement dans le support, et par deux parois extrêmes (50, 60), la première paroi extrême (60) pouvant être indexée sur la machine de transfert et ladite première paroi extrême étant constituée de rails opposés (59) de contact avec la machine de transfert ayant chacun des première (69) et seconde (71) parties et étant chacun sensiblement plat, lesdits rails de contact ayant chacun un bord intérieur (65) vers ladite ouverture et un bord extérieur (67) éloigné de ladite ouverture, lesdits rails s'inclinant à l'écart de ladite première paroi extrême depuis ledit bord intérieur jusqu'audit bord ex-

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térieur, et une rampe surélevée (73) commençant à ladite première partie de chacun desdits rails de contact et s'étendant jusqu'à un point situé entre les première et seconde parties desdits rails de contact afin de former quatre points de contact entre le support et la machine, deux points de contact étant au commencement des rampes et deux autres points de contact étant au bord intérieur desdites secondes parties.

2. Support selon la revendication 1, dans lequel la première paroi extrême est en forme de H, avec un bord en forme de H et une barre horizontale d'indexage entre les rails.

3. Support selon la revendication 1, comportant en outre un rebord de prise par un robot sur le côté extérieur de la première partie de chaque rail.

4. Support selon la revendication 1, dans lequel la rampe arrive à fleur avec le rail entre les première et seconde parties.

5. Support selon la revendication 4, dans lequel la rampe est comprise dans une plage de 0,025 cm à 0,050 cm (0,010 à 0,020 inch) de hauteur et s'étend vers la partie inférieure sur 1 à 2 inches.

6. Support selon la revendication 4, dans lequel la rampe a une largeur d'environ 0,15 cm (0,06 inch).

7. Support selon la revendication 5, dans lequel la rampe a une hauteur d'environ 0,046 cm (0,018 inch).

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