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Schubert

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[54] **APPARATUS FOR USE IN SEMICONDUCTOR CLEANING AND TRANSFERRING PROCESSES**

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[73] Assignee: **Texas Instruments Incorporated,** Dallas, Tex.

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[21] Appl. No.: **25,491**

[52] **U.S. Cl.** ..... **156/541,** 29/203 P, 156/155, 156/236, 156/540, 269/287, 269/321 W, 269/321 WE

[51] **Int. Cl.** **B23q 3/00,** H01r 43/00

[58] **Field of Search** ..... 156/538, 540, 541, 156/494; 248/315; 38/102.2; 269/287, 321 W, 321 WE; 29/203 P, 580, 583

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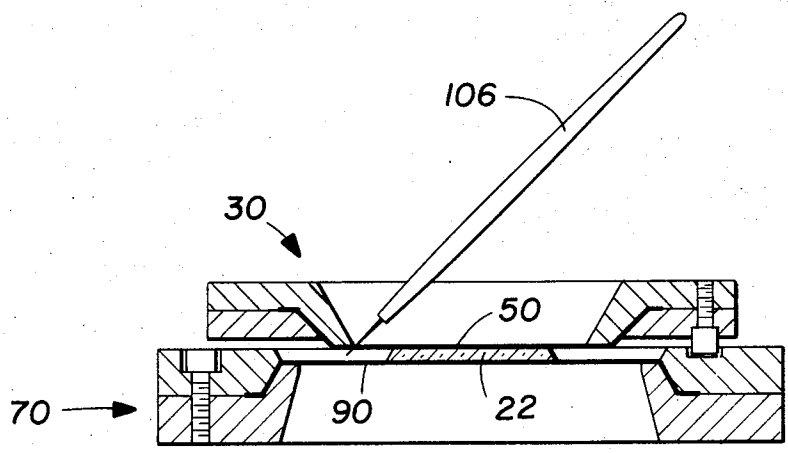
[57] **ABSTRACT**

In a method of cleaning and transferring semiconductors, a paper chip transfer member is glued to a plurality of beam lead chips while the chips are secured to a saphire disk by a layer of wax. Then, the wax is melted to release the chips, and the chips are cleaned by immersing the chips and the transfer member in a wax solvent. After the cleaning step, the chips are secured to a polyester chip receiving member by the simultaneous application of heat and pressure. The transfer member is then released from the chips by immersing the transfer member, the chips and the receiving member in a glue solvent. Finally, the chips are cleaned by immersing the chips and the receiving member in another solvent.

4 Claims, 15 Drawing Figures



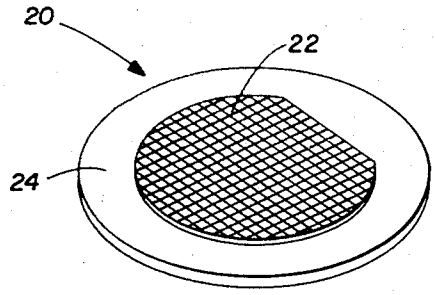


FIG. 1

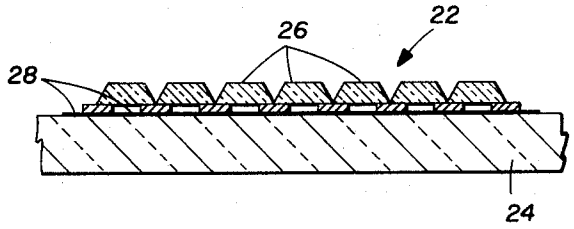


FIG. 2

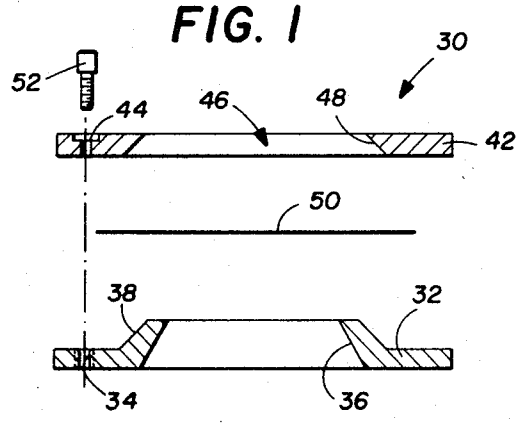


FIG. 3

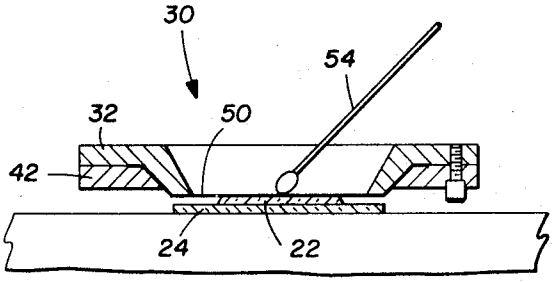


FIG. 4

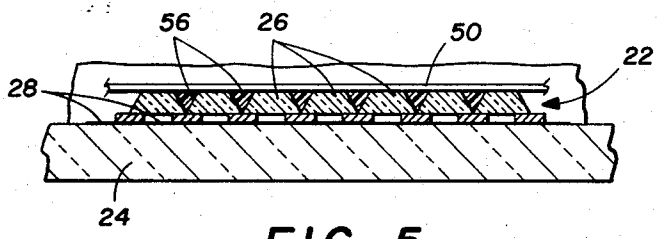


FIG. 5

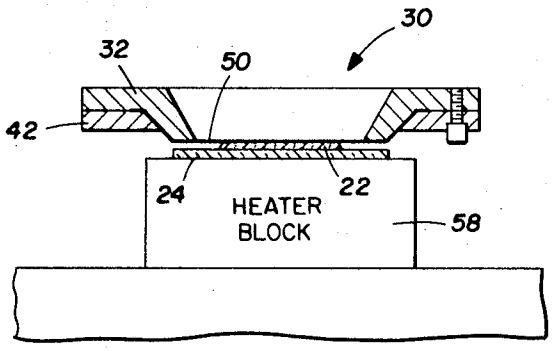


FIG. 6

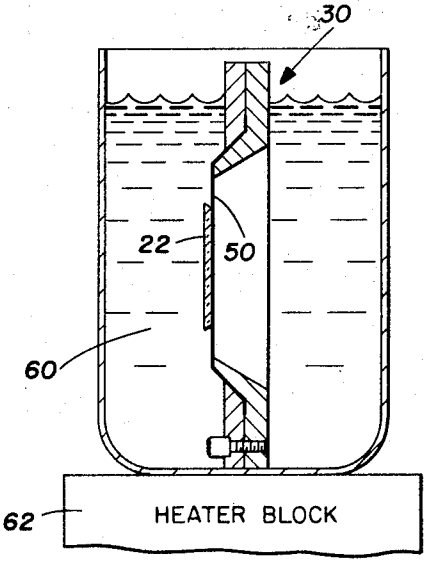


FIG. 7

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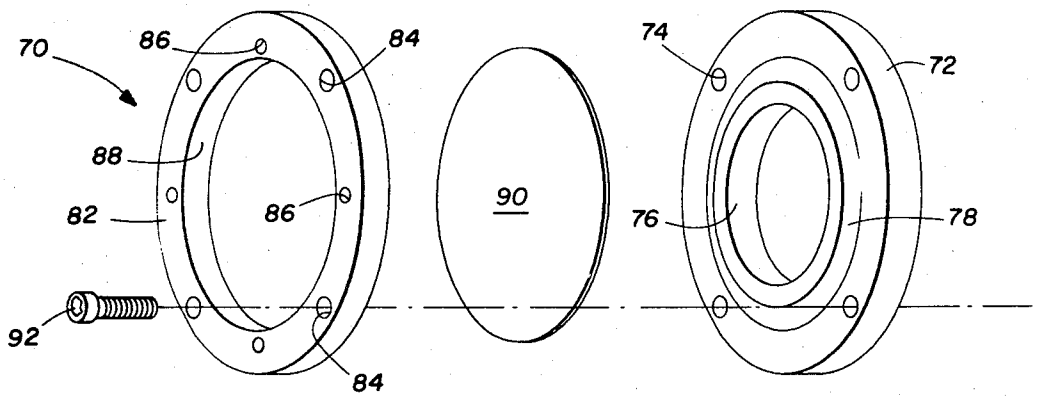

FIG. 8

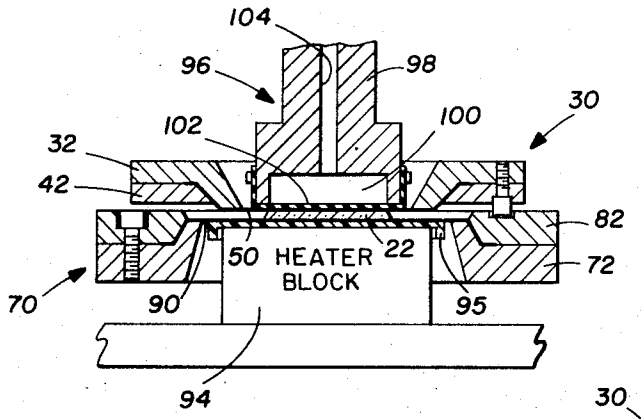

FIG. 9

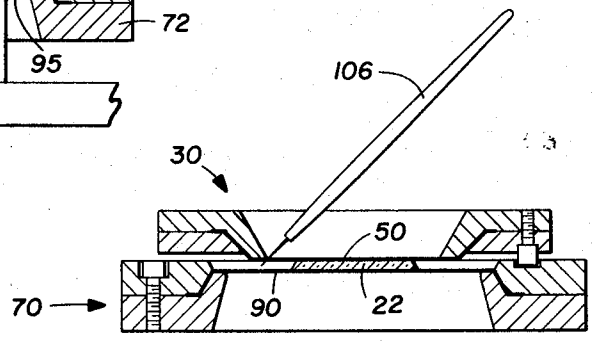

FIG. 10

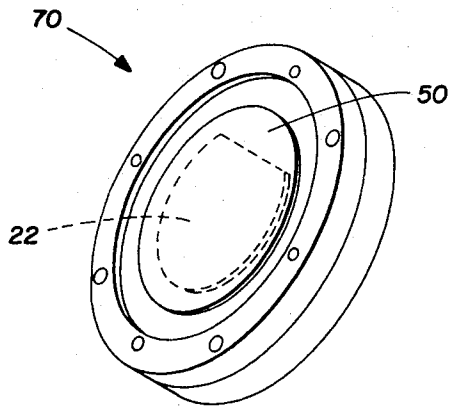

FIG. 11

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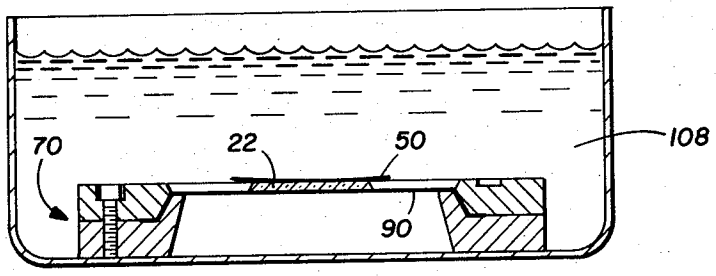

FIG. 12

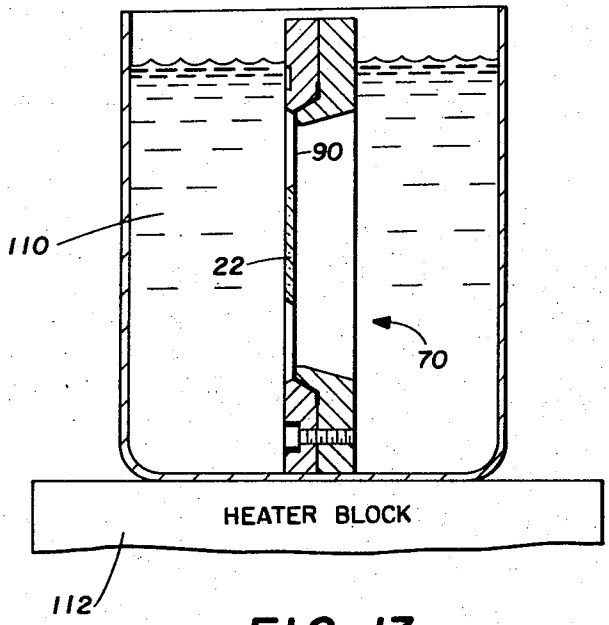

FIG. 13

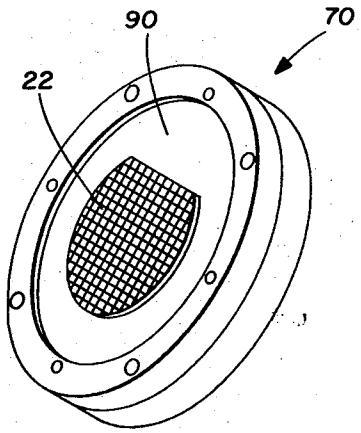

FIG. 15

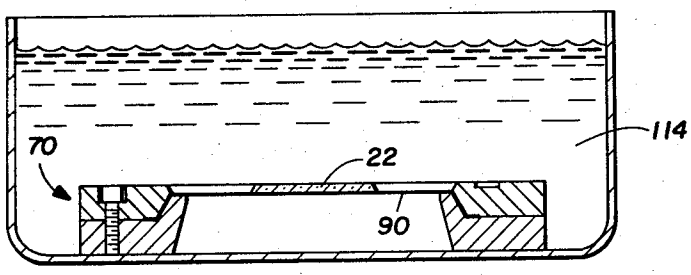

FIG. 14

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APPARATUS FOR USE IN SEMICONDUCTOR CLEANING AND TRANSFERRING PROCESSES

This invention relates to a method of cleaning and transferring semiconductors, and more particularly to a process for accurately and economically cleaning and transferring beam lead chips.

In the semiconductor components manufacturing industry, beam lead chips are fabricated in the form of relatively large slices or wafers, each including a plurality of individual chips. When the fabrication of the unseparated chips comprising such a slice has been completed, the slice is secured to a saphire disk by a layer of wax positioned between the slice and the disk. Then, the slice is separated into individual beam lead chips by separation etching.

Before the individual chips can be used for subsequent product assembly, it is necessary to release the chips from the saphire disk and to clean the wax from the chips. Typically, this is accomplished during the transfer of the chips from the saphire disk to a chip receiving member. For example, in accordance with one prior art cleaning and transferring process, beam lead chips are secured to a wire screen for removal from the saphire disk and for cleaning. After the cleaning operation, the chips are pressed into engagement with a layer of adhesive formed on a glass plate. Finally, the wire screen is removed from the chips.

Beam lead chip cleaning and transferring processes of the type employing wire screen chip transfer members and adhesive coated chip receiving members have several inherent disadvantages. First, the use of such processes frequently results in the loss of between 30 percent and 40 percent of the beam lead chips comprising an individual slice. This greatly increases the unit cost of the remaining chips. Second, such processes do not align the chips on the chip receiving member with sufficient accuracy to permit the subsequent use of automatic mechanisms to remove individual chips from the chip receiving member. Third, such processes do not provide adequate bonding between the chips and the chip receiving member to permit the use of the receiving member as a chip storage device.

The present invention relates to a cleaning and transferring process that does not result in the loss of beam lead chips and that positions the chip on a receiving member in an accurate and secure manner. In accordance with its broader aspects, the invention comprises a process in which a transfer member is secured to at least one semiconductor device while the device is mounted on a supporting member. Thereafter, the device is removed from the supporting member and is cleaned. After the cleaning step, the device is secured to a receiving member. Finally, the transfer member is released from the device.

In accordance with a more specific aspect of the invention, the transfer member is saturated with a solvent and is then secured to a plurality of beam lead chips. Subsequently, the chips are cleaned by immersing the transfer member and the chips in a bath comprising the same solvent. This prevents misalignment of the chips due to distortion of the transfer member upon contact with the bath.

In accordance with another specific aspect of the invention, the cleaning bath is heated and the transfer member is oriented vertically in the bath. This prevents misalignment of the chips due to differential heating between the chips and the transfer member.

In accordance with still another specific aspect of the invention, the transfer member is secured to the chips by an adhesive that is not attacked by the cleaning solvent. After the cleaning step, the chips are secured to a chip receiving member. Then, the transfer member, the chips and the receiving member are immersed in a solvent that does attack the adhesive. The latter solvent releases the transfer member from the chips.

In accordance with yet another specific aspect of the invention, the chips are secured to a polyester chip receiving member. The receiving member is first rendered soft and sticky. Then, the chips are secured to the receiving member by the simultaneous application of heat and pressure.

A more complete understanding of the invention may be had by referring to the following detailed description when taken in conjunction with the drawings, wherein:

FIG. 1 is a perspective view showing a beam lead slice mounted on a saphire disk;

FIG. 2 is an enlarged sectional view of the slice and the disk in which the individual beam lead chips comprising the slice are shown;

FIG. 3 is an exploded sectional view of a beam lead chip transfer member;

FIG. 4 is an illustration of a step in a method of cleaning and transferring semiconductors employing the present invention in which the transfer member is attached to the beam lead chips comprising the slice;

FIG. 5 is an enlared sectional view showing the result of the step shown in FIG. 4;

FIG. 6 is an illustration of a step in the method in which the beam lead chips are removed from the saphire disk;

FIG. 7 is an illustration of a step in which the beam lead chips are cleaned;

FIG. 8 is an exploded perspective view of a beam lead chip receiving member;

FIG. 9 is an illustration of a step in the method 0f cleaning and transferring semiconductors in which the beam lead chips are attached to the chip receiving member;

FIG. 10 is an illustration of a step in the method in which a portion of the transfer member is servered from another portion;

FIG. 11 is a perspective view showing the result of the step shown in FIG. 10;

FIG. 12 is an illustration of a step in the method showing the removal of the portion of the transfer member from the beam lead chips of the slice;

FIG. 13 is an illustration of a step in the method in which the beam lead chips are cleaned;

FIG. 14 is an illustration of another cleaning step, and

FIG. 15 is an illustration of the end result of the method.

Referring now to the drawings, a method of cleaning and transferring semiconductors employing the present invention is shown. Referring particularly to FIGS. 1 and 2, there is shown an assembly 20 comprising a beam lead slice or wafer 22 mounted on a saphire disk 24. At the point in the processing of the slice 22 illustrated in FIGS. 1 and 2, the slice has been separated into a plurality of individual beam lead chips 26 all of which are secured to the disk 24 by a layer of wax 28 positioned between the slice and the disk.

Referring now to FIG. 3, a beam lead chip transfer member 30 is shown. The member 30 includes a first ring 32 formed from aluminum or the like and having a plurality of tapped holes 34 formed through it. The ring 32 is provided with a central aperture 36 and with a male conical gripping surface 38.

The member 30 further includes a second ring 42. The ring 42 is formed from aluminum or the like, and has a plurality of screw receiving holes 44 formed through it. The ring 42 is provided with a central aperture 46 and with a female concial gripping surface 48 that extends at substantially the same angle as the surface 38 of the ring 32.

In the use of the member 30, a membrane 50, such as a layer of lint free filter paper or the like, is first thoroughly wetted with electronic grade trichlorethylene. Then, the membrane 50 is positioned over the aperture 36 in the ring 32. Thereafter, the ring 42 is positioned over the membrane 50 and is secured to the rings 32 by a plurality of screws 52 that extend through the holes 44 of the ring 42 and into threaded interengagement with the tapped holes 34 in the ring 32. As the screws 52 are tightened, the surfaces 38 and 48 on the rings 32 and 42, respectively, cooperate to draw the membrane 50 tightly across the aperture 36 of the ring 32 and to thereafter secure the membrane in a stretched condition.

At the beginning of the semiconductor cleaning and transferring process shown in the drawings, any dust, etc. that may be on the slice 22 is removed. Typically, this is accomplished by directing air pressurized to about 5 PSI toward the slice 22 through a ⅛ inch nozzle positioned about 10 inches from the slice. Thereafter, the transfer member 30 shown in FIG. 3 is secured to the beam lead chips 26 of the assembly 20 shown in FIGS. 1 and 2.

As is shown in FIG. 4, the transfer member 30 is attached to the chips 26 by mounting the assembly 20 on a flat surface and then positioning the membrane 50 of the member 30 in engagement with the chips 26. Thereafter, the membrane 50 is secured to the chips 26 by forcing a glue comprising one-fourth cellulose nitrate and three-fourths electronic grade acetone through the membrane into engagement with the chips. Preferably, this is accomplished by dipping a cotton swab 54 of the type used by doctors, housewives, etc. into the glue and simultaneously pressing the swab against and rolling the swab across the membrane 50. It has been found that the filling of all of the interstices between the chips 26 of the slice 22 can be assured by alternatively rolling the swab 54 across the membrane 50 in mutually perpendicular directions.

When all of the interstices between the chips 26 have been filled with glue, the glue is allowed to set for about 15 minutes. At this point, the transfer member 30 and the assembly 20 are oriented as shown in FIG. 5. That is, the slice 22 is both secured to the saphire disk 24 by a layer of wax 28 and is secured to the membrane of the transfer member 30 by a layer of glue 56. Because the layer of glue 56 fills all of the voids between the individual chips 26 of the slice 22, the slice can be disengaged from the saphire disk 24 without disturbing the orientation of the individual chips comprising the slice.

The chips are preferably removed from the saphire disk 24 in the manner illustrated in FIG. 6. The disk 24 is positioned in engagement with a heater block 58 comprising a resistance heater mounted in a metal block. The resistance heater is operated to bring the temperature of the metal block to about 165° C. This temperature is sufficient to melt the layer of wax 28 between the saphire disk 24 and the slice 22 but is not so high as to damage the chips 26 comprising the slice.

Preferably, the saphire disk 24 is initially positioned in engagement with the block 58 for about 2 minutes. Then the disk 24 is removed from the block 58 and the edges of the slice 22 are carefully separated from the disk 24 by a knife edge. Next, the disk 24 is returned to the heater block 58. After a slight amount of reheating, the entire slice 22 is lifted from the disk 24.

After the slice 22 is removed from the disk 24, the chips 26 comprising the slice are cleaned. Preferably, this is accomplished in the manner shown in FIG. 7, wherein the assembly including the transfer member 30 and the slice 22 is shown positioned in a bath 60 comprising a solvent for the wax that initially secured the slice 22 to the disk 24. In accordance with the preferred embodiment, the bath 60 comprises a quantity of electronic grade trichlorethylene that is maintained at a temperature of between about 80° C and about 85° C by a heater block 62. In such a case, the assembly is retained in the bath 60 for about 4 minutes after which the slice 22 is dried for at least 5 minutes.

It will be noted that the membrane 50 was saturated with trichlorethylene before the assembly of the transfer member 30. This is very important because it eliminates distortion of the membrane 50 when the member 30 is immersed in the bath 60 and thereby prevents misalignment of the chips 26 due to such distortion. It will also be noted that the transfer member 30 is oriented vertically in the bath 60. This is also very important in that it causes the heat from the heater 62 to flow across the slice 22 rather than through the membrane 50. This reduces differential heating between the slice and the membrane and thereby eliminates misalignment of the chips 26 due to such differential heating.

Referring now to FIG. 8, a beam lead chip receiving member 70 is shown. The member 70 comprises a first ring 72 which is similar to the first ring 32 of the transfer member 30 in that it is formed from aluminum or the like and has a plurality of tapped holes 74 formed through it. The ring 72 is provided with a central aperture 76 and with a male conical gripping surface 78.

The member 70 further includes a second ring 82. The ring 82 is similar to the second ring 42 of the member 30 in that it is formed from aluminum or the like and has a plurality of screw receiving holes 84 formed through it. The second ring 82 differs from the ring 42 in that it is provided with a plurality of screw head receiving indentations 86. The ring 82 has a female conical gripping surface 88 that extends at substantially the same angle as the surface 78 of the ring 72.

In the use of the chip receiving member 70, a membrane 90 is positioned over the aperture 76 formed in the first ring 72. Thereafter, the second ring 82 is positioned over the membrane 90 and is secured to the first ring 72 by a plurality of screws 92 that extend through the holes 84 of the ring 82 into threaded interengagement with the tapped holes 74 in the ring 72. During the tightening of the screws 92, the surfaces 78 and 88 on the rings 72 and 82, respectively, cooperate to draw the member 90 tightly across the aperture 76 of the ring 72 and to thereafter secure the membrane 90 in a stretched condition.

In accordance with the preferred embodiment of the invention, the membrane **90** comprises a polyester film, such as polyethylene terephthalate ("MYLAR"). For example, the membrane **90** may be formed from a polyester base, black line, matte surface blueprint paper of the type sold by the Frederick Post Company, Chicago, Illinois under the trademark "DIAZOTYPE" and particularly, the paper identified by the company as Tuftex 208–PEL. Such paper has a 0.003 inch thick polyethylene terephthalate base and a photosensitive surface suitable for development in an ammonia type blueprint machine. When this material is used in the present process, the photosensitive layer is first removed by passing the material through the light exposure position of such a blueprint machine. This renders the photosensitive surface of the paper transparent by removing silver bromide therefrom and thus eliminates any possibility of chip contamination from the silver bromide. Thereafter, the remaining polyester layer is positioned in the beam lead chip receiving member **70** with its dull surface facing the second ring **82.**

The next step in the method of cleaning and transferring beam lead chips shown in the drawings comprise attaching the slice **22** to the membrane **90** of the chip receiving member **70.** As is best shown in FIG. **9,** this is preferably accomplished by mounting the chip receiving member **70** on a heater block **94** comprising a metal block, a resistance heater and a cap **95** formed from tetrafluoroethylene. Then, both the dull surface of the membrane **90** and the surface of the membrane **50** facing away from the slice **22** are thoroughly wetted with electronic grade trichlorethylene.

At this point, the slice **22** is positioned in engagement with a dull surface of the membrane **90.** During this positioning of the transfer member **30,** the heads of the screws **52** enter the indentations **86** of the ring **82** to assure proper alignment of the slice **22** and the receiving member **70.** Then, the chips **26** comprising the slice **22** are attached to the membrane **90** of the member **70** by the immediate application of both heat and pressure.

The heat necessary for the chip attaching step is supplied by the heater block **94** which is operated to heat the chips **26** to between about 150° C and about 200° C depending on the type and size of the chips. The pressure is supplied by a plunger **96** comprising a ram **98** having a cavity **100** formed in its distal end and a rubber membrane **102** mounted across the open end of the cavity **100.** A passageway **104** extends to the cavity **100** for use in pressuring the membrane **102** with compressed air. In the use of the plunger **96,** the force on the ram **98** and the pressure within the cavity **100** are regulated to provide a net force on the chips **26** of between 3 and 30 PSI again depending on the type and size of the chips.

The heat and pressure of the chip attaching step shown in FIG. **9** are maintained for between about 3 minutes and about 6 minutes depending on chip type and size. Then, the assembly comprising the transfer member **30,** the slice **22** and the receiving member **70** is removed from the heater block **94** and the membrane **50** is severed from the rings **32** and **42** comprising the transfer member **30.** This is preferably accomplished in the manner shown in FIG. **10,** that is, by employing a knife **106** to sever the portion of the membrane **50** secured between the rings **32** and **42** from the portion attached to the slice **22.** The result of this step is illustrated in FIG. **11,** wherein the slice **22** is shown mounted on the receiving member **70** and covered by a portion of the membrane **50.**

The next step in the method of cleaning and transferring semiconductors comprises disengaging the portion of the membrane **50** from the slice **22.** As is best shown in FIG. **12,** this is preferably accomplished by immersing the receiving member **70** in a bath **108** comprising a solvent for the glue that was employed in the initial stages of the process to secure the slice **22** to the membrane **50.** The position of the receiving member **70** in the bath **108** is important because if the member **70** is not oriented horizontally in the bath **108,** the chips **26** comprising the slice **22** may become misaligned during the softening of the glue due to the action of gravity.

In accordance with the preferred embodiment, the bath **108** comprises electronic grade acetone and the member **70** is immersed in the bath for between about ten minutes and about twenty minutes depending on the surface conditions of the chips. Ordinarily, this is sufficient to cause the portion of the membrane **50** to float away from the slice **22.** If necessary, however, the portion of the membrane **50** can be pulled away from the slice **22** with tweezers. After the portion of the membrane is removed the assembly comprising the slice **22** and the receiving member **70** is allowed to dry for about 10 minutes.

At the end of the removal step, the transfer of the beam lead chips is complete. All that remains to be accomplished in the process is the cleaning of the remaining glue or other impurities from the chips. Preferably, this is accomplished in the manner shown in FIG. **13,** wherein the member **70** is shown immersed in a bath **110.**

The bath **110** may comprise any suitable glue solvent. Preferably, however, the bath comprises research grade xylene which is maintained at a temperature of about 80° C by a heater **112.** Alternatively, the bath **110** may comprise boiling electronic grade trichloroethylene. Again, the vertical orientation of the slice **22** in the bath **110** is important because it reduces differential heating between the membrane **80** and the slice **22** and thereby prevents misalignment of the chips **26** during the cleaning step. The member **70** is preferably maintained in the bath **110** for about 10 minutes and is thereafter allowed to dry and to cool to room temperature.

After the cleaning step, it is necessary to remove the solvent comprising the bath **110** from the chips comprising the slice **22.** This is preferably accomplished in the manner shown in FIG. **14,** wherein the member **70** is shown immersed in a bath **114** comprising a material that is both a solvent for the material of the bath **110** and that does not leave a residue of the chips **26.** In accordance with the preferred embodiment, the bath **114** is comprised of electronic grade acetone and the member **70** is permitted to remain in the bath for up to about fifteen minutes.

At this point, the method of cleaning and transferring semiconductors according to the present invention is complete. That is, the chips **26** comprising the slice **22** have been completely cleaned and have been transferred from the saphire disk **24** to the chip receiving member **70.** By comparing FIG. **15** with FIG. **1,** it will be noted that at the conclusion of the process, the chips **26** of the slice **22** are oriented in the same manner as they were at the start of the process.

In certain instances, it may be desirable to attach the receiving member **70** to the side of the chips **26** opposite the side that is initially attached to the saphire disk **24.** In such a case, the disk **24** is positioned on the heater block **94** shown in FIG. **9** and the receiving member **70** is assembled in the manner shown in FIG. **8.** Then, the dull surface of the membrane **90** is positioned in engagement with the chips **26,** and the heater block **94** and the plunger **96** are operated to simultaneously apply heat and pressure to the point of engagement between the membrane and the chips. This both attaches the chips **26** to the receiving member **70** and releases the chips from the disk **24.** Subsequently, any remaining wax is removed from the chips by immersing the receiving member and the chips in the bath **60.**

It will be understood that the substances identified herein in conjunction with the preferred embodiment are not critical to the practice of the invention. For example, it is necessary that the glue used in the step shown in FIG. **4** be both insoluble in the wax solvent used in the step shown in FIG. **7** and soluble in the solvent used in the step shown in FIG. **12.** However, within these parameters, the compositions of the glue and the solvents is immaterial and may be varied to suit particular needs.

Likewise, the nature of the transfer member is not critical to the practice of the invention. That is, the membrane of the transfer member can be comprised of any substance that remains dimensionally stable throughout the cleaning and transferring process. Furthermore, the membrane can be supported in any suitable manner and need not be supported in the mechanism shown.

The nature of the receiving member and the method of attaching the chips to the receiving member can also be altered in accordance with the particular requirements. For example, various conventional processes can be employed to mount the chips on various polymeric materials, if desired. Alternatively, the chips may be secured to a resin coated glass plate by simply pressing the chips into engagement with the resin

The use of the present invention in the cleaning and transferring of semiconductors results in several advantages over the prior art. For example, the use of the invention permits the transfer of a semiconductor slice from a supporting member to a receiving member without loss of the chips comprising the slice. Thus, the problem of losing a large percentage of the chips comprising each slice that has characterized most prior cleaning and transferring processes is completely eliminated.

Another very important advantage from the use of the present invention comprises a highly accurate positioning of the chips on the receiving member. In actual practice, chips have been mounted on receiving members within a tolerance of ± 0.001 inch and $\pm 1°$. This permits the subsequent removal of individual chips from the receiving member by automatic mechanisms.

Still another advantage resulting from the use of the present invention involves the bond that is obtained between the chips and the receiving member. Most prior semiconductor cleaning and transferring processes have not formed a chip-receiving member bond of sufficient strength to permit the use of the receiving member as a chip storage device. The present invention, on the other hand, secures chips to receiving members in such a way that the receiving member can be used for long term chip storage.

Although specific embodiment of the invention is shown in the drawings and described herein, it will be understood that the invention is not limited to the embodiment disclosed but is capable of rearrangement, modification and substitution of parts and elements without departing from the spirit of the invention.

What is claimed is:

1. Apparatus of the type used in semiconductor cleaning and transferring processes, comprising in combination:

a. a first ring member having a central aperture of a first diameter and a plurality of selectively located openings formed in close proximity to the outer edge thereof, said first ring member having a tapered portion substantially circumscribing said central aperture to form a substantially conical male gripping surface;

b. a second ring member having a central aperture of a second diameter slightly larger than said first diameter of said first ring member, and a plurality of selectively located openings formed in close proximity to the outer edge thereof with said central aperture having a tapered side wall to form a substantially conical female gripping surface;

c. securing means for selectively passing through respective openings in said first ring member and a co-axial opening in said second ring member for releasably securing together said first and second ring members so that said male gripping surface tightly abuts said female gripping surface; and

d. a flexible membrane having a diameter larger than the central apertures of said first and second ring members positioned therebetween with the peripheral edge thereof lying between said male and female gripping edges in a stretched condition tightly across said central apertures of said first and second ring members.

2. The apparatus of claim **1** wherein at least one of any two coaxially positioned openings in said first and second ring members is internally threaded, and wherein said securing means are externally threaded screws, whereby said screws threadably engage respective openings for securing together said first and second ring members.

3. The apparatus of claim **2** and further including a plurality of indentations formed in close proximity to the edge of said second ring member wherein at least two of said apparatus are relatively aligned in overlying relationship with each other by the respective positioning of the screws of one apparatus and the indentations of the adjacent apparatus.

4. The apparatus of claim **3** wherein one of said aligned apparatus is a chip receiving member and the other is a chip transistor member, whereby a semiconductor chip positioned between the membranes thereof and releasably secured to one of said apparatus is adapted for cleaning and transferring purposes.

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