SPECIFICATION

SEMICONDUCTOR PART FIXING JIG, SEMICONDUCTOR PART PLACING CRADLE, AND BONDING DEVICE

TECHNICAL FIELD

The present invention relates to a semiconductor part fixing jig, a semiconductor part placing cradle, and a bonding device, and in particular to a semiconductor part fixing jig, a semiconductor part placing cradle and a bonding device that are excellent in insulation and wear resistance, low in dust generation and adhesion, and which make possible mass production of high quality semiconductor products.

BACKGROUND ART

In the fabrication process of semiconductor parts such as LSIs, ICs and transistors, a die bonder equipment as shown in FIG. 6 and a wire bonding equipment as shown in FIGs. 9 and 10 are used. The die bonder equipment shown in FIG. 6 is an equipment for bonding or jointing semiconductor elements (pellets or IC chips) to a lead frame. The die bonder equipment includes a wafer cassette ring 2 for holding a large number of semiconductor pellets 1 formed by cutting a wafer stuck on a transparent film, a monitor equipment such as a TV camera (not illustrated) for

monitoring the position and shape of each semiconductor pellet 1 and determining whether standards are satisfied, a vacuum die chuck collet 4 for chucking one by one the semiconductor pellets 1 satisfying the standards and held on the wafer cassette ring 2 and transferring the chucked semiconductor pellet 1 to a pre-alignment device 3, a die bonding collet 6 for chucking the semiconductor pellet 1 positioned by the pre-alignment device 3 and pressing the chucked semiconductor pellet 1 to a predetermined position to a lead frame 5.

A vacuum chuck cylinder 13 is disposed on the opposite side of the wafer cassette ring 2 from the die chuck collet 4. As shown in enlarged views of FIGs. 7 and 8, this chuck cylinder 13 is fabricated by shaping a steel material such as a carbon steel for mechanical structure (S45C) into a cylindrical cap, and plating a surface of the cylindrical cap to be brought into contact with a pellet adhesion film 8 having the semiconductor pellets 1 stuck thereon, with black zinc having a thickness of approximately 2 to 15 μ m.

In a central part of the chuck cylinder 13, a pin insertion hole 14 for inserting a thrust-up pin 7 described later is opened. Around the pin insertion hole 14, a large number of suction holes 15 are opened to effect the vacuum chuck on the film 8. This chuck cylinder 13 is fitted around a sleeve 16 made of a steel material.

The reason why the surface of the chuck cylinder 13 to be brought into contact with the film 8 is plated with black zinc will now be described. When the position and shape of each semiconductor pellet 1 stuck on the film 8 are monitored by using the monitor equipment, the background of the semiconductor pellet 1 providing a relatively bright image is darkened to increase the contrast between the semiconductor pellet 1 and the chuck cylinder 13 serving as the background and thereby facilitate the discrimination of the position and shape of the semiconductor pellet 1.

As shown in FIG. 8, the thrust-up pin 7 is disposed on the opposite side of the film 8 from the die chuck collet 4 so as to be capable of rising and falling in the axis direction. This thrust-up pin 7 is implanted on a mandrel 17 disposed so as to be capable of rising and falling in the center axis direction of the chuck cylinder 13. The thrust-up pin 7 passes through the pin insertion hole 14 of the chuck cylinder 13 from the direction of the rear of the film 8 having a plurality of semiconductor pellets 1 stuck thereon and moves so as to stick into the film 8. Subsequently, the thrust-up pin 7 functions to take off a semiconductor pellet 1 stuck on the top face of the film 8, and move the semiconductor pellet 1 toward the tip of the die chuck collet 4.

In order to ensure the wear resistance strength,

each of the die bonding collet 6 and the die chuck collet 4 is generally made of cemented carbide (hard metal) containing tungsten (W) and cobalt (Co) so as to take a cylindrical shape. At its tip, each of the collets 4 and 6 has a hollow 9 for sucking and holding the semiconductor pellet 1. In its tip, the hollow 9 takes the shape of a frustum of quadrangular pyramid. In communication with this hollow 9, a suction hole 10 for connecting the semiconductor pellet 1 to a vacuum source to effect the vacuum chuck is provided. The thrust-up pin 7 disposed so as to be opposed to the die chuck collet 4 also comes into contact with the pellets 1 repetitively at high speed. Therefore, the thrust-up pin 7 is also made of the above described cemented carbide having high wear resistance so as to take the shape of a columnar needle.

The chuck cylinder 13, the thrust-up pin 7, the die chuck collet 4, and the die bonding collet 6 are configured so as to rise and fall in the vertical direction by a link vertically moved by a cam device which is not illustrated and revolve in the horizontal direction.

When executing the die chuck manipulation, the position and shape of each semiconductor pellet 1 are checked by the monitor equipment in such a state that the chuck cylinder 13 is in contact with the rear of the film 8. Since the surface of the chuck cylinder 13 has plated with black zinc, the contrast between the semiconductor

pellet 1 and the chuck cylinder 13 serving as the background is high. Therefore, the contour of the semiconductor pellet 1 is clearly recognized by using the monitor equipment. Thus semiconductor pellets having a defect such as a crack or an abnormal shape are judged to be rejected and excepted from the subjects of the die bonding.

Out of a plurality of pellets 1, 1, ... , stuck on the top face of the film 8 on the wafer cassette ring 2, the die chuck collet 4 and the chuck cylinder 13 incorporating the thrust-up pin 7 optically sense only accepted pellets and move them in the vertical direction. And the internal space of the chuck cylinder 13 brought into contact with the rear of the film 8 is connected to a vacuum source. Air staying between the film 8 and the chuck cylinder 13 is removed through the suction holes 15. As a result, the film 8 is sucked and fixed to the outer surface of the chuck cylinder 13. Subsequently, the thrust-up pin 7 rises through the pin insertion hole 14 of the chuck cylinder 13, breaks through the film 8, thrusts up a semiconductor pellet 1 which has come in contact with the tip of the pin, and takes off the semiconductor pellet 1 from the top face of the film 8. At the same time, the semiconductor pellet 1 is covered by the tip (hollow) of the die chuck collet 4. The die chuck collet 4 vacuum-chucks the semiconductor pellets 1 into the hollow 9

one by one and successively transfers the semiconductor pellets 1 to the pre-alignment device 3 shown in FIG. 6.

The pre-alignment device 3 positions the transferred semiconductor pellet 1. The positioned semiconductor pellet 1 is transferred while being vacuum-chucked in the tip of the die bonding collet 6 and placed in a predetermined position of the lead frame 5. Since the collet 6 applies a scrub motion to the semiconductor pellet 1, the semiconductor pellet 1 is subjected to a strong pushing pressure. Since solder for bonding is applied to the surface of the lead frame 5 beforehand, the semiconductor pellet 1 is integrally bonded to the lead frame 5 as one body.

Then, each electrode of the semiconductor pellet 1 and a lead 5a of the lead frame 5 are electrically connected together via a wire by using a wire bonding equipment 20 shown in FIGs. 9 and 10. FIG. 9 shows the entire configuration of the bonding equipment, whereas FIG. 10 shows the configuration of a bonding head functioning as a principal part of the bonding equipment.

The wire bonding equipment as shown in FIG. 9 is an equipment for connecting an electrode of a semiconductor part placed on a semiconductor part placing cradle (bonding stage) to the lead by using the bonding wire. On a bonding head 101 including a bonding collet having the bonding wire inserted therethrough, there is mounted an ITV camera

including a camera head, a lens and an illumination lamp for detecting the position of the semiconductor part and the bonding state. This bonding head 101 is mounted on an X-Y table drive mechanism (not illustrated) which can move in the X direction and Y direction. The ITV camera in this bonding head 101 shoots the lead frame 5 which is a bonded part transferred onto the semiconductor part placing cradle 102 and positioned.

On both sides of the semiconductor part placing cradle 102, one pair of guide rails 104a and 104b are disposed. The lead frame 5 is positioned in the width direction by the guide rails 104a and 104b, and is guided to a predetermined position while being regulated in position so as not to meander at the time of transfer. On the sending side of this lead frame 5, a loader 105 is disposed. On the receiving side of the lead frame, an unloader 106 is disposed. The loader 105 has a sending mechanism for positioning a magazine 107 capable of housing a plurality of lead frames 5 to a predetermined position and for automatically sending the magazine onto a transfer path on the semiconductor part placing cradle 102. The unloader 106 has a receiving mechanism for receiving the magazine 107 from the transfer path in the same way.

Under the semiconductor part placing cradle 102, there is disposed heating means 108, such as a heater plate, for heating the lead frame 5 which is a part to be

bonded to a temperature of approximately 200 to 300 ℃. Since this heater plate 108 is disposed along the longitudinal direction of the pair of guide rails 104a and 104b, the heater plate 108 can simultaneously heat a plurality of semiconductor devices (IC chips) 1 bonded to the lead frame 5. As a result of this heating manipulation, an electrode of a semiconductor device 1 positioned on the semiconductor part placing cradle 102 and a lead 5a of the lead frame 5 are electrically connected together by thermo-compression bonding of a bonding wire 21.

As for the bonding stage, i.e., the semiconductor part placing cradle subjected to this bonding connection, a base metal formed by a SUS stainless steel material having a black hard chromium plating layer or a nickel plating layer formed as its coating layer on its surface has been mainly used heretofore. By thus providing the surface of the semiconductor part placing cradle with the black color and thereby increasing the contrast between the cradle and semiconductor parts such as the semiconductor device and the lead frame, the position detection precision is raised.

In other words, image signals of the semiconductor parts and the cradle taken by the ITV camera added to the bonding head are processed in a binarization circuit included in image processing means. For example, the lead is provided with a bright color, whereas other portions are provided with dark colors. Conversion to digital signals is

thus conducted. By using the signals, coordinate positions of the lead and so on are detected.

The configuration of the bonding head serving as a principal portion of the bonding equipment will now be described by referring to FIG. 10. The bonding head 101 has a wire bonding capillary 22 for holding a bonding wire 21 inserted therethrough. The bonding wire 21 is made of a conductive material such as gold (Au) or aluminum (Al). This capillary 22 is configured so as to be moved in the X, Y and Z directions by a bonding head which is not illustrated.

Furthermore in the bonding head, a discharge electrode 23 is disposed so that its discharge portion 23a may freely approach and leave a place located just under the capillary 22. In addition, a lead frame retainer 24 made of a metal for pressing and fixing the lead frame 5 is provided. This lead frame retainer 24 is adapted to be raised and lowered by drive means 25. This lead frame retainer 24 is a flat board shaped conductive member having an opening 26 in its central portion. The opening 26 can surround the semiconductor pellet 1 and the leads 5a of the lead frame 5. When the lead frame retainer 24 has been lowered, the lead frame 5 is sandwiched between the lead frame retainer 24 and a bonding stage 27 such as a heater block and fixed to a predetermined position.

The wire bonding equipment 20 operates as

hereafter described. When the lead frame 5 has been transferred into the bonding stage 27, the lead frame retainer 24 is lowered by the driving means 25 and the lead frame 5 is sandwiched between the lead frame retainer 24 and the bonding stage 27 and fixed. Subsequently, the discharge electrode 23 is moved and positioned so that its discharge portion 23a will be located just under the capillary 22. By discharge between the discharge portion 23a and the capillary 22, a ball (nail head) 21a is formed at a free end of the bonding wire 21 led from the capillary 22. Thereafter, the capillary 22 is controlled to move by a bonding head which is not illustrated. An electrode on the semiconductor pellet 1 is electrically connected to a lead 5a by the bonding wire 21. When the bonding manipulation for one semiconductor pellet 1 placed on the transfer line has been completed, the lead frame retainer 24 rises and the lead frame 5 is transferred by a predetermined distance. The bonding manipulation is repeated for the next semiconductor pellet in the same way.

However, in the conventional die bonder equipment including a semiconductor part fixing jig such as the chuck cylinder formed by using the carbon steel for mechanical structure (S45C) and having black zinc plating on its surface, the wear resistance strength of the chuck cylinder is low. This results in drawbacks that the production yield of semiconductor parts such as semiconductor pellet joint

substances is lowered and the maintenance management of the fabrication equipments becomes complicated.

In other words, the film having pellets stuck thereon and the top face of the chuck cylinder slide with each other whenever the die bonding operation is repeated at high speed. Therefore, the black zinc plating on the surface of the chuck cylinder tends to wear and peel off. It thus becomes impossible to obtain the black background at the time of monitoring. When confirming the position and shape of a semiconductor pellet by using the monitor equipment, therefore, recognition mistakes tend to occur. Thus there is a fear that the fraction defective of the products increases suddenly.

In a short running period, therefore, it is necessary to replace the chuck cylinder at high frequency. Whenever the chuck cylinder is thus replaced, the die bonder equipment is obliged to be stopped. This results in a problem that continuous running for a long time period is difficult and labor required for the maintenance management of the equipment also increases.

On the other hand, in the conventional wire bonding equipment using the lead frame retainer as the fixing jig, the lead frame retainer is formed by using a conductive material such as a metal. Therefore, in the case where a sufficient insulation distance cannot be ensured between the discharge electrode and the lead frame

retainer, there occurs a problem that the discharge to be caused between the discharge electrode and the wire often occurs between the discharge electrode and the lead frame.

When such a phenomenon has occurred, a ball for bonding is not formed at the free end of the bonding wire. This results in a problem that stable bonding work cannot be carried out due to defective bonding.

As a countermeasure for reducing the above described troubles, there is put to practical use a lead frame retainer having a insulating coating made of ceramics, heat resisting hard rubber, heat resisting plastics, or carbon formed on the main body of the lead frame retainer as disclosed in Japanese Patent Application KOKAI Publication No. 7-78843. However, each of these insulating coatings is formed of coarse grains. Thus there is a problem of insufficient wear resistance strength and insulation, high dust generation, and tendency to degradation of semiconductor parts due to adhesion of dust.

In the conventional bonding equipment including a semiconductor part placing cradle formed with a black metal plating layer on the surface of a base metal such as stainless steel as a coating layer, the wear resistance of the cradle and the joint strength of the coating layer are low. This results in a drawback of a lowered yield of semiconductor parts such as semiconductor circuit substrates and complicated maintenance and management of

the fabrication equipments.

In other words, the lead frame and the top surface of the cradle slide with each other whenever high speed bonding operation is completed for each semiconductor device. Therefore, the black metal plating layer on the surface of the cradle is liable to wear or peel off. It thus becomes impossible to obtain the black background at the time of monitoring. To be concrete, the black plating layer on the cradle peels off at the time of bonding, and the white base metal is exposed. This results in a drawback that a coordinate position different from the normal coordinate position is detected when automatically recognizing the coordinate position of a lead or the like processed by the binarization circuit included in the image processor.

As a result, when confirming the position and shape of a semiconductor device or a lead by using the monitor equipment, the recognition mistakes tend to occur. Thus, there is a fear that the fraction defective of the products increases suddenly. In a short running period, therefore, it is necessary to replace the cradle at high frequency. Whenever the cradle is thus replaced, the bonding equipment must be stopped. This results in a problem that continuous running for a long time period is difficult and labor required for the maintenance management of the equipment also increases.

In the conventional semiconductor part placing cradle, the bonding (joint) strength between the base metal and the coating layer is weak and the coating layer is liable to peel off. By this peeling off, dust is generated. The dust adheres to the semiconductor parts which are the products, and degrades their characteristics. This results in a problem of a lowered production yield of the semiconductor parts.

In the case where the cradle having the black metal plating layer formed thereon is used as in the conventional bonding equipment, inter-metal joint occurs between a soldering material component such as silver (Ag) plated on the bottom face of the lead frame and an iron metal component of the cradle when the lead frame is transferred on the cradle. This results in a fear of sticking of the lead frame to the cradle and the lead frame being bent or deformed. If the wire bonding manipulation is conducted in this state, the bonding wire is deformed. Anyway, there occurs a problem of increased joint defects.

As a countermeasure for solving the above described problems, there is disclosed a bonding equipment using a cradle having an insulating coating made of Al_2O_3-TiO_2 ceramics formed on the surface of a stainless steel base metal as described in Utility Model Publication No. 6-10684. However, the above described problems are not eliminated.

The present invention has been made to eliminate the above described problems. An object of the present invention is to provide a semiconductor part fixing jig capable of having a high bonding strength and wear resistance of the coating layer, reducing the generation and adherence of dust, and mass-producing high quality semiconductor parts with a high production yield.

Another object of the present invention is to provide a semiconductor part placing cradle capable of having a high wear resistance, reducing the generation and adherence of dust caused by peeling off of the coating, and accurately recognizing the coordinate position of a lead or the like at the time of bonding or the like, and provide a bonding equipment using such a cradle.

DISCLOSURE OF THE INVENTION

In order to achieve the above described objects, a semiconductor part fixing jig and a semiconductor part placing cradle according to the present invention are characterized in that a coating layer having a chromium oxide as its chief ingredient has been formed on the surface of the base metal.

They are characterized in that the chromium (III) oxide is a second chromium oxide (Cr_2O_3). Furthermore, they are characterized in that the chromium (III) oxide consists of second chromium oxide (Cr_2O_3) fine grains having an

average grain size (diameter) of 0.1 to 0.5 μm. The coating layer having this chromium oxide as its chief ingredient exhibits a deep dark green color.

Preferably, the coating layer is formed on the surface of the base metal having a surface roughness of 5 μm or more in terms of maximum height (Rmax) reference. To be concrete, prior to forming the coating layer, the surface of the base metal is made rough so as to have the roughness of 5μm or more in terms of Rmax reference by blasting processing or the like, and thereafter the coating layer is formed. By thus making the surface of the base metal rough so as to have a value of 5μm or more in terms of Rmax reference, it is possible to increase the bonding strength of the joint with the coating layer and simultaneously make rougher the surface roughness of the semiconductor part fixing jig and the cradle after forming the coating layer. If the surface roughness in terms of Rmax reference exceeds 10 μm, however, it becomes difficult to form the coating layer uniformly. Therefore, the surface roughness of 10 μm or less is preferred.

Specifically, in the case where the base metal is iron metal, it is preferred to form a reaction layer of an iron compound and a chromium oxide between the base metal and the coating layer containing the chromium oxide as its chief ingredient. By forming this reaction layer, it is possible to further increase the bonding strength of joint

with the coating layer containing the chromium oxide as its chief ingredient. As for the expression "having a coating layer containing a chromium oxide as its chief ingredient formed on the surface of the base metal," it is a matter of course that the case where the coating layer is formed via the reaction layer is also within the scope of the present invention. Apart from whether the interface is definite or not, substantially two coating layers, i.e., the reaction layer and the coating layer containing the chromium oxide as its chief ingredient are formed on the surface of the base metal.

The above described semiconductor part fixing jig is suitable for the lead frame retainer for pressing and fixing the lead frame which joints a semiconductor device and the chuck cylinder for chucking and fixing a semiconductor device. The above described semiconductor part placing cradle is suited to the cradle for placing thereon a semiconductor device so as to be freely slidable. As a matter of course, the above described semiconductor part placing cradle is not limited to the use in bonding equipments, but it can be also used for placing semiconductor parts thereon when transferring them.

A bonding equipment according to the present invention is characterized in that in a bonding equipment for connecting an electrode of a semiconductor part placed on a semiconductor part placing cradle to a lead, the

semiconductor part placing cradle has a coating layer containing a chromium oxide as its chief ingredient formed on the surface of a base metal.

As material for the base metal described above, it is not especially limited, but general-purpose structural steel member, anti-corrosive steel, heat-resisting steel such as stainless steel, various kinds of iron alloys, carbon steel, a titanium alloy, an aluminum alloy, Inconel or the like may be used.

The coating layer containing a chromium oxide as its chief ingredient can be formed by using a procedure hereafter described. For example. a chromium oxide (CrO_3) water solution or slurry (slip) is applied to the surface of the base metal of a iron metal or the like subjected to surface processing beforehand, or the surface of the base metal is immersed in the chromium oxide (CrO_3) water solution or slurry (slip). As a result, the chromium oxide water solution or slurry (slip) adheres to the surface of the base metal.

Subsequently, heating and firing are conducted at a low temperature of approximately 400 to 600 ℃. As a result, water is evaporated. At the same time, a reaction layer is generated by a chemical reaction between the chromium oxide and the surface layer of the base metal, and a coating layer containing chromium oxide (chromium (III) oxide: Cr_2O_3) fine grains of 0.1 to 0.5 μm in average

diameter as its chief ingredient are formed.

As to the thickness of these coating layers, the total thickness of the reaction layer and the coating layer containing chromium oxide as its chief ingredient is preferably in the range of 1 to 5 μm. In the case where the thickness of the coating layers is less than 1μm, the insulation and the wear resistance of the fixing jig decrease. In the case where fine ceramic grains or flakes described later are not added to or contained in the reaction layer and the coating layer containing chromium oxide as its chief ingredient, the coating layers exceeding 5 μm conversely impair the evenness of the coating layer thickness and lower the adhesion and the bonding strength. For a similar reason, the range of 1 to 3 μm is more desirable as the thickness.

On the other hand, characteristics (such as bonding strength and surface hardness) of the coating layers can be further improved by adding fine ceramic grains (corpuscles) and flakes such as alumina (Al_2O_3), silica (SiO_2), or ZnO_2 to a chromium oxide (Cr_2O_3) aqueous solution. To be concrete, it is desirable to adjust the quantity of the addition so that the coating layers (the reaction layer and the coating layer containing chromium oxide as its chief ingredient) formed on the surface of the base metal may contain the above described fine ceramic grains (corpuscles) and flakes in the range of 30 to 50

wt%. However, in the case where fine ceramic grains and flakes such as Al_2O_3 are thus added, it is desirable that the thickness of the coating layers is in the range of 15 to 80 μ m.

If the thickness of the coating layers is less than 15 μ m, the effect of improving the bonding strength is poor. On the contrary, if the thickness of the coating layers exceeds 80 μ m, then the strength of the coating layer itself containing chromium oxide (and ceramics corpuscles and flakes) as its chief ingredient becomes weak, and consequently the adhesion strength and the bonding strength fall in the end. For a similar reason, the thickness range of 20 to 60 μ m is more desirable.

The coating layer thus containing the fine ceramic grains and the like may be formed by using a production method instead of the above described production method. In other words, an aqueous solution or slurry containing the fine ceramic grains is applied to the surface of the base metal, and heating and firing are conducted at a temperature of 500 to 600℃ to form a porous ceramic layer. Thereafter, the ceramic layer is impregnated with a chromium oxide (CrO_3) aqueous solution or slurry, and subjected to heating and firing at a temperature in the range of 500 to 600 ℃. The coating layer may thus be formed.

If the above described application and

impregnation manipulation of the raw material liquid and the firing manipulation are conducted only once, minute pores are liable to remain in the coating layer. Under normal conditions, therefore, it is desirable to repeat the application and impregnation manipulation of the aqueous solution and the firing manipulation approximately ten times. The thickness of the coating layers can be adjusted by controlling the number of repetition times of the application and impregnation manipulation and the firing manipulation.

The coating layer formed as described above has a high bonding strength with respect to the base metal, high hardness and no pores, and it is excellent in wear resistance, low friction property, and heat resisting property. The surface hardness obtained when stainless steel is used as the base metal is affected slightly by the hardness of the base metal and is in the range of 500 to 600 Hv (0.1). On the other hand, the surface hardness of a thick coating layer containing the aggregates is as high as 1500 to 2000 Hv (0.1), and hardness close to that of cemented carbide is obtained.

Especially in the case where iron base metal is used, a reaction layer is generated on the interface between the coating layer and the base metal by chemical reaction caused between chromium oxide and the metal (iron). Due to the existence of this reaction layer, the

bonding strength between them becomes at least 700 kgf/cm² (68 MPa).

In addition, the average diameter of chromium oxide (Cr_2O_3) fine grains forming the coating layer is as extremely fine as approximately 0.1 to 0.5μm. Therefore, it intensely acts as a solid lubricant. Even if the surface roughness (Rmax) is somewhat great, therefore, its coefficient of friction becomes small and the effect of enhancing the sliding characteristics is also significant. Especially since the coating layer is formed by precipitation from aqueous solution, the constituent particles are extremely fine. Unlike the porous ceramic coated film formed by the conventional spraying method, insufficiency of corrosion resistance or wear resistance is not caused.

Since the surface of the coating layer is formed minutely, it is excellent in heat resistance and thermal shock resistance. Even if the repetitive heat cycle acts upon the semiconductor part fixing jig and the cradle, peeling off of the coating layer is hardly caused and dust generation is hardly caused by the peeling off.

Furthermore, the coating layer has an excellent corrosion resistance with respect to an acid solution such as sulfuric acid, a basic solution such as ammonia water, and an organic solvent such as alcohol, acetone, or gasoline as well. Even in a severe atmosphere, the coating

layer has an excellent endurance.

By thus forming the coating layer, the function of the base metal can be significantly enhanced. Especially when it is used as a constituent member of the chuck cylinder of the die bonder equipment, the lead frame retainer of the wire bonding equipment, the cradle, or the fixing jig, or a constituent member of the sliding portion such as the heater plate, an excellent effect is obtained.

The coating layer exhibits dark green color. When the semiconductor part fixing jig is used as the chuck cylinder of the die bonder equipment, or when the semiconductor part placing cradle is used as the part placing cradle of the bonding equipment, the contrast between the semiconductor device or lead and the chuck cylinder or the cradle serving as the background becomes high. The shape of the semiconductor device and the position of the lead are thus recognized clearly by using the monitor equipment such as a television camera. Therefore, recognition mistakes of the semiconductor device and recognition mistakes of the coordinate position of the lead or the like are reduced. As a result, semiconductor parts can be fabricated with high precision.

The coating layer is formed minutely by extremely fine chromium oxide particles (grains). If the coating layer is formed on the base metal itself of the semiconductor part fixing jig or the cradle according to

the present invention without conducting the processing for adjusting the surface roughness, therefore, the surface roughness of the fixing jig or the cradle also becomes 1 to 2 μm in term of Rmax reference in the same way as the surface roughness of the base metal, resulting in a smooth surface.

As for the semiconductor part fixing jig and the cradle according to the present invention, therefore, it is desirable to conduct roughness raising processing such as the blasting processing on the base metal itself beforehand to make the surface roughness (Rmax) of the base metal itself at least 5.0 μm and then form the coating layer. By adjusting the surface roughness of the base metal beforehand, it is possible to provide the semiconductor part fixing jig and the cradle having the coating layer according to the present invention with the surface roughness (Rmax) in the range of 3 to 5 μm and uniform coating layer thickness. Besides the improvement of the bonding strength, it becomes possible to prevent dust generated in the semiconductor fabrication equipment at the time of use from adhering to the semiconductor part, and make the dust adhere to the fixing jig and the cradle. Therefore, contamination of the semiconductor part which is the product caused by the dust can be efficiently prevented, and high quality semiconductor parts can be mass-produced with a high production yield.

In the semiconductor part fixing jig and the cradle according to the above described configurations, the coating layer containing extremely fine chromium oxide grains (corpuscles) is formed on the surface of the base metal. As a result, the insulation and wear resistance of the fixing jig and the cradle are high, and it is possible to prevent the generation and adhesion of dust. When this fixing jig and the cradle are used as the chuck cylinder of a die bonder equipment, or the lead frame retainer, cradle or a sliding part of a wire bonding equipment, therefore, it becomes possible to mass-produce high quality semiconductor parts with little defects and with a high production yield.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an enlarged sectional view showing an embodiment of a die bonder equipment incorporating a chuck cylinder as a semiconductor part fixing jig according to the present invention, and showing only a die chuck portion serving as a principal portion;

FIG. 2 is a perspective and sectional view showing an embodiment of a lead frame retainer serving as a semiconductor part fixing jig according to the present invention;

FIG. 3 is a sectional view showing an embodiment of a semiconductor part placing cradle according to the

present invention;

FIG. 4 is an enlarged sectional view of a portion IV shown in FIG. 3;

FIG. 5 is a sectional view showing another embodiment of a semiconductor part placing cradle according to the present invention;

FIG. 6 is a perspective view showing an example of a configuration of a die bonder equipment;

FIG. 7 is an enlarged perspective view of a chuck cylinder shown in FIG. 6;

FIG. 8 is an enlarged sectional view of a die chuck portion of a conventional die bonder equipment;

FIG. 9 is a plain view schematically showing the configuration of a bonding equipment; and

FIG. 10 is a perspective view showing the configuration of a bonding head portion of a wire bonding equipment.

BEST MODE FOR EMBODYING THE INVENTION

Embodiments of the present invention will now be described with reference to the accompanying drawing.

Embodiments 1 through 5:

Cylindrical chuck plates 13b each having a bottom and each being composed of mechanical structural carbon steel (S45C), alloy tool steel (SKD), or stainless steel (SUS304) subjected to blasting processing beforehand so as

to have the surface roughness (Rmax) of 7 to 8μm as a base metal were prepared as shown in TABLE 1 and FIG. 1. The process of applying a chromium oxide (CrO_3) saturated solution (containing fine SiO_2 grains or the like added thereto depending on the embodiment) to the surface of each chuck plate 13b, and the process of firing each chuck plate at a temperature of 500 ℃ were repeated. As a result, chuck cylinders 13a serving as semiconductor part fixing jig according to embodiments 1 through 5 as shown in TABLE 1 were prepared. By fitting each chuck cylinder 13A on the top opening of the cylindrical sleeve 16A made of S45C, the chuck cylinder having the shape shown in FIG. 7 is formed. The chuck cylinder 13A and the cylindrical sleeve 16A may be integrally formed as one body beforehand.

Comparative Example 1:

As comparative example 1, carbon steel for mechanical structure (S45C) used as a conventional material was subjected to machine grinding work to form a chuck cylinder material body taking the shape of a cylindrical cap and having the same dimensions as the embodiment 1. The surface of the material body opposed to the film was plated with zinc so as to have a thickness of 10 μm. A large number of chuck cylinders made of S45C were thus prepared.

The bonding strength (peel strength) of the coating layer of each of chuck cylinders prepared in the embodiments 1 through 5 and the comparative example 1 was

measured. In addition, each chuck cylinder was mounted as the chuck cylinder 13A of the die bonding equipment shown in FIG. 1. The work of bonding Si pellets each having 0.35 mm as one side to a lead frame was consecutively carried out one million times. Thereafter, an average wear amount of each chuck cylinder caused by sliding of its portion brought into contact with the film was measured, and results shown in TABLE 1 were obtained.

TABLE 1

Table 1

Sample No.	Kind of Base Metal of Chuck Cylinder	Surface Roughness of Base Metal Rmax (μm)	Coating Layer				Bonding Strength of Coating Layer (MPa)	Average Wear Amount (μm)
			Kind	Thickness (μm)	Ceramic Fine Grains Kind	Ceramic Fine Grains Content (vol.%)		
Embodiment 1	S45C	7.1	Cr_2O_3	3.0	—	—	70	1.4
Embodiment 2	SKD	7.4	Cr_2O_3	2.8	—	—	71	1.2
Embodiment 3	SKD	7.3	Cr_2O_3	45	SiO_2	30	94	0.5
Embodiment 4	SUS304	7.5	Cr_2O_3	2.7	—	—	74	1.4
Embodiment 5	SUS304	7.2	Cr_2O_3	2.5	—	—	73	1.3
Comparative Example 1	S45C	2.1	Zinc plating	10	—	—	22	Suspension of Use due to Plating peel off

As apparent from the results shown in TABLE 1, the chuck cylinder serving as the semiconductor part fixing jig according to the embodiments 1 through 5 has a higher bonding strength, a small wear amount, and a significantly prolonged life as compared with the chuck cylinder of the comparative example 1 using the conventional material. Furthermore, since the occurrence ratio of semiconductor pellet recognition mistakes in the monitor equipment is significantly reduced, the production yield can be significantly improved.

Furthermore, since each chuck cylinder has excellent wear resistance and a prolonged life, it becomes unnecessary to stop the die bonder equipment at high frequency in order to replace the chuck cylinder. It thus becomes possible to run the equipment continuously for a long period of time. The maintenance and management of the equipment can be significantly simplified, and the production efficiency of semiconductors and the like can be significantly improved.

Embodiments in which the semiconductor part fixing jig according to the present invention is used as the lead frame retainer of a wire bonding equipment will now be described.

Embodiments 6 through 10:

Lead frame retainer main bodies each being

composed of mechanical structural carbon steel (S45C), alloy tool steel (SKD), or stainless steel (SUS304) subjected to blasting processing beforehand so as to have the surface roughness (Rmax) of 7 to 8μm as a base metal 28 and having an opening 26 for wire bonding manipulation were prepared as shown in TABLE 2 and FIG. 2. Subsequently, the process of applying a chromium oxide (CrO_3) saturated solution (containing fine ceramic grains in the embodiments 7 through 9) to the surface of each lead frame retainer main body, and the process of firing each lead frame retainer main body at a temperature of 500℃ were repeated. Thereby, a coating layer 29 having the thickness shown in TABLE 2 and containing CrO_3 was formed. As a result, a lead frame retainer 24a serving as the semiconductor part fixing jig according to each of the embodiments 6 through 10 as shown in FIG. 2 was fabricated.

Comparative Example 2:

Except that a zinc plating layer having a thickness of 10 μm was formed as the coating layer instead of the coating layer 29 containing Cr_2O_3, processing was conducted under the same condition as the embodiment 6. A lead frame retainer serving as the semiconductor part fixing jig according to comparative example 2 was thus fabricated.

The bonding strength (peel strength) of the coating layer of each of lead frame retainers prepared in

the embodiments 6 through 10 and the comparative example 2 was measured. In addition, each lead frame retainer was mounted as the lead frame retainer 24 of the wire bonding equipment shown in FIG. 10. Characteristics such as the wear resistance and the dust generation quantity of each lead frame retainer were measured, and the results shown in TABLE 2 were obtained.

TABLE 2

Table 2

Sample No.	Kind of Base Metal of Lead Frame Retainer	Surface Roughness of Base Metal Rmax (μm)	Coating Layer				Bonding Strength of Coating Layer (MPa)	Average Wear Amount (μm)
			Kind	Thickness (μm)	Ceramic Fine Grains			
					Kind	Content (vol.%)		
Embodiment 6	S45C	7.2	Cr_2O_3	3	—	—	70	1.7
Embodiment 7	SKD	7.4	Cr_2O_3	52	SiO_2	32	94	0.4
Embodiment 8	SKD	7.3	Cr_2O_3	45	SiO_2	38	96	0.5
Embodiment 9	SUS304	7.1	Cr_2O_3	48	Al_2O_3	35	92	0.6
Embodiment 10	SUS304	7.2	Cr_2O_3	2.8	—	—	72	1.6
Comparative Example 2	S45C	2.0	Zinc plating	10	—	—	19	Suspension of Use due to Plating peel off

As is apparent from the results shown in TABLE 2, the lead frame retainer containing fine CrO_3 grains (corpuscles) and having a minute, highly hard coating layer formed thereon according to each embodiment has a higher bonding strength with respect to the coating layer and a lower peel off as compared with the lead frame retainer of the comparative example 2 using the conventional material. Furthermore, since the quantity of dust generated by the sliding with respect to the lead frame is significantly reduced, the production yield of the semiconductor parts can be significantly improved.

Embodiments in which the semiconductor part placing cradle according to the present invention is applied to the cradle of a bonding equipment will now be described by referring to accompanying drawing.

Embodiments 11 through 15:

Flat plane shaped cradle main bodies 111 each being composed of mechanical structural carbon steel (S45C), alloy tool steel (SKD), or stainless steel (SUS304) subjected to blasting processing beforehand so as to have the surface roughness (Rmax) of 7 to 8μm as a base metal were prepared as shown in TABLE 3 and FIG. 3. The process of applying a chromium oxide (CrO_3) saturated solution (containing fine SiO_2 grains added thereto depending on the embodiment) to both surfaces of each cradle main body 111, and the process of firing each cradle main body 111 at a

temperature of 500℃ were repeated. Thus coating layers 112 each having a thickness shown in TABLE 3 were formed on both surfaces of each cradle main body 111. As a result, semiconductor part placing cradles according to embodiments 11 through 15 as shown in TABLE 3 were prepared.

As shown in FIG. 4, the coating layer 112 of the semiconductor part placing cradle 113 according to each embodiment was formed by a chromium oxide layer 114 containing extremely fine chromium oxide (Cr_2O_3) grains having an average grain diameter of 0.1 to 0.5μm and a reaction layer 115 generated by chemical reaction between chromium oxide and an iron component of the base metal.

Comparative Examples 3 through 5:

As comparative examples 3 through 5, carbon steel for mechanical structure (S45C) or stainless steel (SUS 304) used as a conventional material as shown in TABLE 3 was subjected to machine grinding work to form a flat plane shaped cradle main body having the same dimension as the embodiment 11. On the surface of the cradle main body to be brought into contact with the lead frame, a chromium plating layer (comparative example 3), a nickel plating layer (comparative example 4), or a zinc plating layer (comparative example 4) each having a thickness shown in TABLE 3 was formed. A large number of semiconductor part placing cradles according to the comparative examples 3 through 5 were thus prepared.

For each of cradles prepared in the embodiments and comparative examples, the bonding strength of the coating layer was measured by using a peel test method. In addition, each cradle was mounted as the semiconductor part placing cradle 102 of the bonding equipment shown in FIG. 9. Characteristics such as insulation, wear resistance, and dust generation quantity of each cradle were measured, compared and evaluated.

In other words, wire bonding was conducted consecutively one hundred millions times, and then the occurrence ratio of defects of semiconductor parts caused by defective wire joint and an average wear amount of the semiconductor part placing cradle were measured. Thus results shown in TABLE 3 were obtained.

TABLE 3

Table 3

Sample No.	Kind of Cradle Main Body (Base Metal)	Surface Roughness of Base Metal Rmax (μm)	Coating Layer				Bonding Strength of Coating Layer (MPa)	Fraction Defective of Semiconductor Parts (%)	Average Wear Amount (μm)
			Kind	Thickness (μm)	Ceramic Fine Grains				
					Kind	Content (vol.%)			
Embodiment 11	S45C	7.0	Cr_2O_3	3	—	—	72	0.15	2.2
Embodiment 12	SKD	7.5	Cr_2O_3	4	—	—	75	0.12	2.0
Embodiment 13	SKD	7.2	Cr_2O_3	40	SiO_2	35	85	0.14	1.2
Embodiment 14	SUS304	7.5	Cr_2O_3	3	—	—	76	0.13	1.9
Embodiment 15	SUS304	7.3	Cr_2O_3	4	—	—	76	0.15	1.8
Comparative Example 3	SUS304	2.5	Cr plating	10	—	—	20	Suspension of Use due to Plating peel off	
Comparative Example 4	SUS304	2.0	Ni plating	15	—	—	26	Suspension of Use due to Plating peel off	
Comparative Example 5	S45C	2.0	Zr plating	15	—	—	22	Suspension of Use due to Plating peel off	

As is apparent from the results shown in TABLE 3, the semiconductor part placing cradle containing the fine CrO_2 grains and having a minute, highly hard coating layer formed thereon according to each embodiment causes less defective parts due to defective wire joint as compared with the cradle of each of the comparative examples using the conventional material. Especially since the bonding strength between the base metal and the coating layer is significantly increased as compared with the conventional technique, the coating layer hardly peels off. Dust generation due to peeling off of the coating layer and adhesion of the generated dust to the lead frame hardly occur. Furthermore, it was observed that most of dust slightly generated in the semiconductor part placing cradle according to each embodiment adhered to a side of the cradle. In other words, the quantity of dust caused by sliding with respect to the lead frame and the quantity of adhering dust are significantly reduced. As a result, the production yield of the semiconductor parts can be significantly improved.

Embodiment 16:

In the same way as the embodiments 11 through 15 except that a cradle main body 111a having an indent 116 formed on the surface thereof as shown in FIG. 5 according to the shapes of semiconductor devices (IC chips) and the lead frames was used, the coating layer 112 containing fine

Cr_2O_3 grains was formed on the surface of the cradle main body 111a. Thus, a semiconductor part placing cradle 113a according to an embodiment 16 was prepared.

The cradle 113a having the indent 116 formed thereon was also mounted as the cradle 102 of the bonding equipment shown in FIG. 9 in the same way as the embodiments 11 through 15. Its characteristics such as the wear resistance, life, and dust generation quantity were measured. As a result, values equivalent to those of the embodiments 11 through 15 were obtained. In other words, dust generation due to peeling off of the coating layer and adhesion of the generated dust to the lead frame hardly occurred. Contamination of the semiconductor parts could be thus efficiently reduced. In addition, the natural decrease of the coating layer was less. Also in the recognition operation of the lead coordinate position using the monitor equipment (the ITV camera), errors were few. It thus became possible to significantly reduce troubles such as wire joint position defects.

INDUSTRIAL APPLICABILITY

In the semiconductor part fixing jig and the cradle according to the present invention described above, the coating layer containing extremely fine chromium oxide grains (corpuscles) is formed on the surface of the base metal as heretofore described. As a result, the bonding

strength is high, and the insulation and wear resistance of handled parts are high. In addition, it is possible to prevent the generation and adhesion of dust. When this semiconductor part fixing jig and the cradle are used as constituent materials of the chuck cylinder of a die bonder equipment, or the lead frame retainer, cradle or a sliding part of a wire bonding equipment, therefore, it becomes possible to mass-produce high quality semiconductor parts with little defects and with a high production yield.

Furthermore, it becomes unnecessary to stop semiconductor fabrication equipments such as a die bonder equipment and a wire bonding equipment at high frequency in order to replace the chuck cylinder, lead frame retainer, or cradle. It thus becomes possible to run the equipments continuously for a long period of time. The maintenance and management of the equipments can be significantly simplified, and the production efficiency of semiconductor products can be significantly improved.



PATENT CLAIMS

1. A semiconductor part fixing jig characterized in that a coating layer containing chromium oxide as chief ingredient thereof has been formed on a surface of a base metal.

2. A semiconductor part fixing jig according to claim 1, characterized in that the chromium oxide is chromium (III) oxide (Cr_2O_3).

3. A semiconductor part fixing jig according to claim 1, characterized in that the chromium oxide comprises chromium (III) oxide (Cr_2O_3) grains having an average grain diameter in the range of 0.1 to 0.5 μm.

4. A semiconductor part fixing jig according to claim 1, characterized in that the coating layer has a dark green color.

5. A semiconductor part fixing jig according to claim 1, characterized in that the coating layer has been formed on the surface of a base metal having a surface roughness of at least 5 μm in terms of maximum height (Rmax) reference.

* C L M S *

6. A semiconductor part fixing jig according to claim 1, characterized in that a reaction layer composed of a reaction product of an iron compound and a chromium oxide has been formed at an interface between the base metal and the coating layer.

7. A semiconductor part fixing jig according to claim 1, characterized in that the semiconductor part fixing jig is a lead frame retainer for pressing and fixing a lead frame to which semiconductor elements should be bonded.

8. A semiconductor part fixing jig according to claim 1, characterized in that the semiconductor part fixing jig is a chuck cylinder for fixing a semiconductor element by vacuum chuck.

9. A semiconductor part placing cradle characterized in that a coating layer containing chromium oxide as chief ingredient thereof has been formed on a surface of a base metal.

10. A semiconductor part placing cradle according to claim 9, characterized in that the chromium oxide is chromium (III) oxide (Cr_2O_3).

11. A semiconductor part placing cradle according to

* C L M S *

claim 9, characterized in that the chromium oxide comprises fine chromium (III) oxide (Cr_2O_3) grains having an average grain diameter in the range of 0.1 to 0.5 μm.

12. A semiconductor part placing cradle according to claim 9, characterized in that the coating layer has a dark green color.

13. A semiconductor part placing cradle according to claim 9, characterized in that the coating layer has been formed on the surface of a base metal having a surface roughness of at least 5.0 μm in terms of maximum height (Rmax) reference.

14. A semiconductor part placing cradle according to claim 9, characterized in that a reaction layer composed of a reaction product of an iron compound and a chromium oxide has been formed at an interface between the base metal and the coating layer.

15. A bonding device for connecting an electrode of a semiconductor part placed on a semiconductor part placing cradle to a lead, characterized in that said semiconductor part placing cradle has a coating layer containing chromium oxide as chief ingredient thereof formed on a surface of a base metal.

16. A bonding device according to claim 15, characterized in that the coating layer has a dark green color, and the coating layer has been formed on the surface of a base metal having a surface roughness of at least 5.0μm in terms of maximum height (Rmax) reference.