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CONDUCTIVE REGION FORMATION METHOD BY ION INJECTION

Field of the Invention

The present invention relates to a conductive region formation method by ion injection, and more particularly, to a method of forming a conductive region on the device made of polymer compound by an ion injection process.

Description of Prior Arts

Generally, circuit devices such as electronic devices, semiconductor devices, etc. are manufactured by sequentially carrying out specific fabrication processes according to a drawing for design, and the produced circuit devices as products are loaded inside a carrier box as a transportation means before being moved to where they are supposed to be moved.

While the circuit devices are transported, the circuit devices can be fatally damaged due to static electricity generated in the contact between the circuit devices and the carrier box.

Therefore, the means of transporting the circuit devices is generally made of polymer compounds. As the transporting means, there are a CSP(chip scale package) type semiconductor carrier tape, a semiconductor wafer transporting carrier, a printed circuit board carrier box, an electronic module product carrier box, a LCD(liquid crystal display) carrier box, a LCD thin film carrier box, a LCD module carrier box, a circuit device package container and a tray, etc.

In addition, a film, a sheet, a board, a vacuum mold articles, and a plastic mold, etc. to be protected from electronic waves to keep its intrinsic function are made of polymer compound having conductivity.

For example, in case of a film to be protected from electronic waves, conductive material is deposited on its top to form a conductive film.

A conventional film, a sheet, a board, a vacuum mold articles, and a plastic mold, etc. are made by adding additives such as expensive carbon and carbon fiber, etc. to polymer compound, which is light, transparent and easily-moldable resin based materials, for the purpose of easy transportation and then carrying out a press-molding.

The conventional transportation means of circuit devices, the sheet, the board, the

vacuum mold and the plastic mold, etc. become heavier when the additive is added, because the polymer compound become heavier. Transportation means and sheet of circuit devices, board, vacuum mold and plastic mold, etc. become nontransparent because polymer compounds turn to be nontransparent by the added additive.

However, since the transportation means, the sheet, the boards, the vacuum mold, and the plastic injection mold made of polymer compound with the additive added become heavier by the added additive, transportation expenses to be spent for the transportation means becomes higher.

Also, since the material of the polymer compound is nontransparent by the added additive, and the transportation means made of polymer compound is also nontransparent, the words saying the shape, size, properties of the products, etc. cannot be easily recognizable. Therefore, the lower part of the transportation means is made of conductive nontransparent material, and the upper part thereof is made of nonconductive normal transparent material. However, the transported products contact with the nonconductive upper part and are damaged by static electricity.

Also, the products in the transportation means often get fatally damaged due to the difference of the conductivities on various parts of the transportation means because the transportation means is made by adding additives on the polymer compounds.

Also, the use of the additive such as high-priced carbon and carbon fiber for the conductivity formation increased the manufacturing expenses of the transportation means.

Also, such the transportation means manufactured as above cannot be reused because of the additive mixed in the polymer compound of which the transportation means, the sheet, the boards, the vacuum mold, and the plastic injection mold are made, and the transported products are in a high risk of being fatally damaged by the static electricity served as a generation source from the additive particles separated off the polymer compound.

In addition, the provision of conductivity with the product made by depositing conductive material on the product such as a conductive film often causes the conductive film to peel off when the adhesion on the interface between the film and the conductive film is decreased, and the chemical reaction of the deposited material causes chemical transformation on the film.

Summary of the Invention

The present invention is directed to provide a method of forming a conductive region onto a device such as a transportation means, and a film, etc., which is made of polymer compound, by carrying out a three-dimensional ion injection process so that the device weighs less than conventional ones.

Another object of the present invention is to provide a method of forming a conductive region onto a device such as a transportation means, and a film, etc., which is made of polymer compound, by carrying out a three-dimensional ion injection process so that the device maintains its intrinsic transparency.

Further object of the present invention is to provide a method of forming a conductive region onto a device such as a transportation means, and a film, etc., which is made of polymer compound, by carrying out a three-dimensional ion injection process so that a conductive region is formed on the whole surface of the device uniformly.

Still further object of the present invention is to provide a method of forming a conductive region onto a device such as a transportation means, and a film, etc., which is made of polymer compound, by carrying out a three-dimensional ion injection process in order to solve the conventional problems wherein a conductive film deposited on the device surface is taken off, and the properties of the device is transformed.

Still further object of the present invention is to provide a method of forming a conductive region onto a device such as a transportation means, and a film, etc., which is made of polymer compound, by carrying out just one process of three-dimensional ion injection.

Brief Description of the Drawings

Fig. 1 is a schematic view of the ion injection apparatus to show the method of forming a conductive region by a three-dimensional plasma ion injection according to the present invention;

Fig. 2 is a perspective view to show the inner chamber and the outer chamber of Fig. 1;

Fig. 3 is a processing flow chart to show a method of forming a conductive region on the surface of a LCD module carrier box by a three dimensional plasma ion injection according to the present invention; and

Fig. 4 is a view of the changes of the molecular chains on the surface of a LCD module carrier box by a three dimensional plasma ion injection thereon.

Detailed Description of the Preferred Embodiments

Fig. 1 is a schematic view of the ion injection apparatus to show the method of forming a conductive region by a three-dimensional plasma ion injection according to the present invention, and Fig. 2 is a perspective view to show the inner chamber and the outer chamber of Fig. 1.

An apparatus for forming a conductive region on a device such as a LCD(liquid crystal display) module carrier box by a plasma ion injection according to the present invention is provided inside a clean room wherein the number of particles needs limiting strictly. Fig. 1 shows a loading part(2) comprising polymer compound LCD module carrier boxes(4), which are loaded by order.

A widely-used standard transparent polymer such as transparent polymer, Polyethylene(PE), Polypropylene(PP), High-Impact-Polystyrene(HIPS), polyethyleneterephthalate (PET), Acrylonitrile-Butadiene-Styrene (ABS), etc., engineering plastic such as Polycarbonate(PC), Nylon6(N6), Nylon66(N66), Modified Polypenylene Oxide(MPPO), Polysulfon(Psu), Polyethersulfon(PES), Polyether-etherketone(PEEK), etc., unctionally-characterized compound plastic which is made by adding a filler, etc. as an additive to the standard polymer or the engineering plastic to further provide some functional properties and the like.

There is provided a first prechamber(6) where the LCD module carrier boxes(4) of the loading part(2) wait for a while after loaded by a transportation means for the process. The first prechamber(6) maintains its inner pressure 10^{-4} Torr by the pumping of a first vacuum pump(8).

The first prechamber(6) and a processing chamber(11), in which an ion injection process is carried in the state of cold plasma, are connected each other through a gate valve(10) displaced between them. As shown in Fig. 2, the process chamber(11) comprises a cylindrical-shaped outer chamber(12) and an inner chamber(14) displaced

therein. A plurality of through holes(15) are formed on the surface of the inner chamber(14) and there inside is provided a holder(26) which is rotatable with 90 holding the both ends of the LCD module carrier box(4) introduced from the first prechamber(6).

In addition, a high vacuum pump(16) is connected to the outer chamber(12) of the process chamber(11) in order to maintain the inner pressure of the space between the outer chamber(12) and the inner chamber(14) 10^{-6} Torr.

In addition, a gas supply source(20) is connected to one end of the outer chamber(12) of the process chamber(11) in order to supply process gas such as nitrogen(N), argon(Ar), helium(He), hydrogen(H), etc. into the space between the outer chamber(12) and the inner chamber(14), and an ion gun(22) is connected into the other end of the outer chamber(12) of the process chamber(11) in order to supply ions generated from the nitrogen(N), argon(Ar), helium(He), hydrogen(H), etc. into the space between the outer chamber(12) and the inner chamber(14), too.

In addition, a power source(28) is connected to the inner chamber(14) of the process chamber(11) to apply high frequency power controlled by a pulse generator(not shown), and the power source(28), the outer chamber(12) and the inner chamber(14) are grounded at the same point.

In addition, the process chamber(11) and a second prechamber(30) are connected each other through a gate valve(32) between them. The second prechamber(30) maintains its inner pressure 10^{-4} Torr by pumping of the second low vacuum pump(34).

Now herein after, there is provided a detailed description for the method of forming a conductive region on the LCD module carrier box by using the ion injection apparatus described as above referring to Fig. 3.

As shown in the S2 of Fig. 3, the method of forming a conductive region by three dimensional plasma ion injection process according to the present invention starts by introducing a LCD module carrier box(4) as an object device for the conductive region to be formed on into an inner chamber(14) of a process chamber(11). The LCD module carrier box(4) is introduced into the inner chamber(14) through a gate valve(10) by a transportation means after being moved into a first prechamber(6) by the transportation means from a loading part(2), the first prechamber(6) maintaining its inner pressure 10^{-4} Torr or so by a first low vacuum pump(8).

Then, in the S4, the gas supply source(20) supplies process gas into the space

between the outer chamber(12) and the inner chamber(14), and the process gas turns into the state of cold plasma by magnetic field which is generated in the space between the outer chamber(12) and the inner chamber(14) by the high frequency power applied to the inner chamber(14). The high frequency power has specific current, voltage and frequency controlled by a pulse generator of the power source(28).

Then, in the S6, an ion gun(22) supplies ions generated from nitrogen gas, argon gas, helium gas and hydrogen gas, etc. into the space between the outer chamber(12) and the inner chamber(14).

Next, in the S8, the ions in the state of cold plasma between the space between the outer chamber(12) and the inner chamber(14) are supplied into the inner chamber(14) through the through holes(15) thereof, and first ions are supplied on the whole surface of the LCD module carrier box(4) three dimensionally. The ion energy in the first ion injection process is in the range of 30 KeV to 2 GeV, and the injection of the ions into the LCD module carrier box(4) is precisely controlled wherein, for example, the ions can be injected with the thickness of hundreds of Å to a few μm and the surface resistance of 10E8 Ω/Square to 10E9 Ω/Square in the region of 10E4 Ω/Square to 10E13 Ω/Square. Ion dose can be ranged from 1 X 10² ions/cm² to 5 X 10²⁰ ions/cm² or more.

Next, in the S10, the LCD module carrier box(4) rotates with 90° or continuously moves with a certain degrees back and forth.

Then, in the S12, the second ion injection process is carried out by injecting ions with one more time on the whole surface of the LCD module carrier box(4) three dimensionally so that the conductive region formed by the first ion injection is the more enhanced. The above S12 can be omitted, but since the amount of the injected ions are not uniform throughout some surface areas of the LCD module carrier box(4), it is necessary to make the injected ion dose uniform throughout the whole surface of the LCD module box(4) by rotating it with 90° , or continuously moving back and forth with a certain degrees. At this time, as shown in Fig. 4a, chemical bonds can be saturated by the first and the second ion injection throughout the whole surface of the LCD module carrier box(4), or as shown in Fig. 4b, the chains can be broken, or as shown in Fig. 4c, cross-linking of chains can be generated so that the conductive region as desired is formed and additionally the hardness of the surface becomes much more increased. Also, the types of the ions can be selected, and ion energy can be

controlled so that the surface of the LCD module carrier box(4) wears hydrophilic property or hydrophobic property. Antisalt treatment provided by the ion injection can be also improved. Also, the designated notes for the LCD modules loaded inside the LCD module carrier box(4) can be easily recognizable because the carrier box(4) maintains its transparency formed on the conductive region by the ion injection. In addition, since the LCD module carrier box(4) according to the present invention maintains its weight, it weighs less than the conventional LCD module carrier box. Finally, in the S14 step, the LCD module carrier box(4) having the conductive region formed thereon inside the inner chamber(14) of the process chamber(11) is discharged out of the chamber. The discharge of the LCD module carrier box(4) is carried out by moving the LCD module carrier box(4) through the gate valve(32) by the transportation means to a second prechamber(30) maintaining its inner pressure with 10^{-4} Torr by a second low vacuum pump(34).

The present invention is not limited on the LCD module carrier box just described as above, and it is apparent that the present invention can be used in various types of object devices such as a chip tray, a tape for semiconductor carrier, a semiconductor wafer transporting carrier, a printed circuit board carrier box, an electronic module product carrier box, a LCD(liquid crystal display) carrier box, a LCD thin film carrier box, a LCD module carrier box, a sheet, a socket for semiconductor carrier, and vehicle parts for antielectronic waves and for the protection from electrostatic damages, which are made by using polymer compound of a widely used standard polymer such as transparent polymer, Polyethylene(PE), an engineering plastic such as Polypropylene(PP), High-Impact-Polystyrene(HIPS), polyethyleneterephthalate(PET), Nylon6(N6), Nylon66(N66), Modified Polypenylene Oxide(MPPO), Polysulfon(PSU), Polyethersulfon(PES), Polyether-etherketone(PEEK), etc. and a functionally-characterized compound plastic which is made by adding a filler, etc. as an additive to the standard polymer or the engineering plastic, etc.

According to the present invention, the conductive region is formed on the surface of the object device, which is made of polymer compound, by injecting accelerated ions on the surface three dimensionally in cold plasma. Therefore, since the conductive region is formed uniformly, the device becomes lighter than the conventional device which was made through the process of adding an additive such as carbon and carbon fiber so as to save the expenses for transportation thereof, maintain its intrinsic

transparency, and make a uniform conductive region be formed on the whole surface.

Also, in case that the device is a film, it is prevented that the layer deposited on the film peels off, and the chemical property is transformed.

In addition, the surface hardness of the device can be increased, and the manufacturing expenses can be saved because not using the high-priced carbon and carbon fiber.

In addition, the problems of nontransparency, low reusability, low processing ability, etc. occurred when using carbon, carbon fiber, and their mixture, etc. are solved. Also, it is prevented that the carbon particles on the surface of the device are served as a contamination source.

In this disclosure, there is shown and described only the preferred embodiment of the invention but, as aforementioned, it is to be understood that the invention is capable of use in various other combinations and environments and is capable of changes or modifications within the scope of the inventive concept as expressed herein.

What is claimed is:

1. A method of forming a conductive region on an object of polymer compound by injecting accelerated ions in a process chamber which comprises a porous inner chamber and an outer chamber, the method comprising the steps of:

introducing the object into the inner chamber;

supplying a process gas into a space between the inner and outer chambers with applying high frequency power to the inner chamber from a power source to generate magnetic field in said space;

supplying ions generated from N₂, Ar, He and H₂ gases etc. by ion generating means into the space between the inner and outer chambers; and

supplying the ions in the state of cold plasma in the space into the inner chamber through holes thereof to form conductive region on the surface of the object.

2. The conductive region formation method by ion injection, wherein the ions are injected three-dimensionally.

3. The conductive region formation method by ion injection according to claim 1, wherein the polymer compound is one of transparent polymer, standard polymer, engineering plastic and compound plastic having specific properties resulting from adding additives such as filler, etc.

4. The conductive region formation method by ion injection according to claim 1, wherein the device is one of a LCD module carrier box, a chip tray, tape for semiconductor carrier, a carrier for transporting semiconductor wafers, transportation equipment for printed circuit boards, transportation equipment for electronic modules, a LCD, a LCD thin film, sheet, sockets for transporting semiconductor devices, and vehicle components for protection from electronic waves and electrostatic damages.