

A METHOD FOR FABRICATING SEMICONDUCTOR ARTICLES AND SYSTEM THEREOF

FIELD OF INVENTION

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The present invention relates to a method for fabricating semiconductor articles and its system thereof.

BACKGROUND OF THE INVENTION

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In recent years, the spread of integrated circuit packages has been promoted, and further reduction of its thickness thereof is now demanded. Accordingly, it is now required that the thickness of semiconductor chips, which has been about 350 μm , be reduced to about 50-100 μm or less. Such thin semiconductor chips can be obtained by first
15 sticking a surface protective sheet to a circuit surface of a wafer, subsequently grinding the wafer back and thereafter dicing the wafer. When the thickness of the wafer after the grinding is extremely small, chip breakage and chip cracking are likely to occur at the time of the dicing of the wafer.

20 Many technologies related to fabricating semiconductor articles have been proposed to further improve the system. For example, a United States patent with publication no. US8679895B2 discloses embodiments related to integrated circuit (IC) circuit sensors being fabricated using thin-wafer manufacturing technologies which include processing in which dicing before grinding (DBG) is utilized, which can improve reliability and
25 minimize stress effects on the wafer. While other embodiments utilize face-up mounting, face-down mounting is made possible by through-contacts. Another United States patent with publication no. US6558975B2 discloses a process for producing a semiconductor device comprising the steps of providing a wafer having a surface furnished with semiconductor circuits and a back; forming grooves of a depth smaller

than the thickness of the wafer, said grooves extending from the wafer circuit surface; sticking a surface protective sheet onto the wafer circuit surface, grinding the back of the wafer so that the thickness of the wafer is reduced, subsequently reducing in division of the wafer into individual chips with spaces therebetween; sticking a pressure sensitive adhesive sheet onto the ground back of the wafer, exposing the adhesive layer to an energy source; and peeling the surface protective sheet from the wafer circuit surface. A publication by Weng et. al recites a method of stress dicing on semiconductor devices for reduction of defects as well as die strength enhancement, whereby partial stress dicing is performed before grinding of the wafer die. The publication further reports on the elimination of mechanical and absorptive laser singulation related defects such as front side and backside surface ablation, and topside, backside and edge chipping. Besides that, a technology as disclosed by a United States patent with publication no. US6337258B1 recites a method of dividing a wafer by forming grooves in an element formation surface of a wafer along dicing lines or chip dividing lines, whereby the grooves are deeper than a thickness of a finished chip. The method further discloses a holding member being attached on the element formation surface of the wafer and a bottom surface of the wafer is lapped and polished to the thickness of the finished chip, thereby dividing the wafer into chips, before being transferred while being held by porous adsorption.

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The aforementioned patent documents describe the many systems and methods for fabricating semiconductor articles, which are key components in the proposed invention. A major drawback arises therefrom as the systems and methods as disclosed in the prior arts lack a means for removing adhesive sheets from the semiconductor wafers without having to peel them from said wafers. Therefore, there exists a need for such a system that is able to perform a dicing before grinding process and also employs a means for eliminating the adhesiveness of the adhesive sheets by simply applying adequate pressure and heat onto said sheets.

SUMMARY OF INVENTION

It is an object of the present invention to reduce and potentially eliminate risks of backside chipping due to conventional methods of dicing the wafer after backside
5 grinding, whereby the present invention reverses the process by dicing firstly before grinding. It is also an object of the present invention to improve the wafer die strength.

Besides that, it is also an object of the present invention to provide a method of separating wafer dies from a carrier without having to peel of an adhesive sheet that is
10 laminated on one surface of the wafer.

In an aspect of the present invention, there is provided a method for fabricating semiconductor articles comprising the steps of partially cutting a wafer, applying one or more layers of adhesive sheet onto a carrier, transferring the partially cut wafer onto
15 the adhesive sheet on the carrier; grinding a backside of the wafer to a desired thickness to form separated dies, and removing the separated dies from the carrier, wherein the separated dies are removed from the carrier by adhering another layer of adhesive sheet to the backside of the separated dies, in which a heated plate is pressed onto said adhesive sheet thereafter.

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Preferably, the layers of adhesive sheet include a thermal tape and an ultraviolet (UV) tape.

Preferably, the additional layer of adhesive sheet is a dicing tape.

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Preferably, the carrier is made of silicon and/or glass.

Preferably, the wafer is partially cut up to 20% from total wafer thickness.

Preferably, the heated plate is pressed onto the adhesive sheet and the separated dies for a predetermined period.

In another aspect of the invention, there is provided a system for fabricating semiconductor articles comprising a sawing blade for partially cutting a wafer, an adhesive applying mechanism to apply one or more layers of adhesive sheets onto a carrier (203), a transferring mechanism to transfer the partially cut wafer (200) onto the carrier (203), a back grinding wheel for grinding a backside of the wafer to form separated dies, wherein the separated dies are removed from the carrier by adhering another layer of adhesive sheet to the backside of the separated dies, in which a heated plate is pressed onto said adhesive sheet thereafter.

Preferably, the system further comprises a sorting mechanism for sorting the dies upon inspection.

Preferably, the carrier is made of silicon and/or glass.

Preferably, the adhesive layers include a thermal tape, an ultraviolet (UV) tape, and a dicing tape.

One skilled in the art will readily appreciate that the present invention is well adapted to carry out the objects and obtain the ends and advantages mentioned, as well as those inherent therein. The embodiment described herein is not intended as limitations on the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

For the purpose of facilitating an understanding of the invention, there is illustrated in the accompanying drawing the preferred embodiments from an inspection of which

when considered in connection with the following description, the invention, its construction and operation and many of its advantages would be readily understood and appreciated.

5 **FIG. 1** is a flow chart illustrating a process of manufacturing a semiconductor wafer.

FIG. 2 is a flow chart illustrating a process of partial cutting and backside grinding a semiconductor wafer.

10 **FIG. 3** is a flow chart illustrating a first technique of applying one or more adhesive sheets to a carrier and front side of the wafer.

FIG. 4 is a flow chart illustrating a first technique of removing the wafer from the carrier.

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FIG. 5 is a flow chart illustrating a second technique of applying the adhesive sheet to the carrier and front side of the wafer.

20 **FIG. 6** is a flow chart illustrating a second technique of removing the wafer from the carrier.

DETAILED DESCRIPTION OF THE INVENTION

Hereinafter, the invention shall be described according to the preferred embodiments
25 of the present invention and by referring to the accompanying description and drawings. However, it is to be understood that limiting the description to the preferred embodiments of the invention is merely to facilitate discussion of the present invention and it is envisioned that those skilled in the art may devise various modifications without departing from the scope of the appended claim.

The invention will now be described in greater detail, by way of example with reference to the drawings.

FIG. 1 is a flow chart illustrating a method for fabricating semiconductor articles according to the present invention, the method comprising the steps of firstly receiving a semiconductor article, preferably a semiconductor wafer **200** at Step **101**, then inspected through incoming quality control (IQC) at Step **102**. IQC is a process of controlling quality of materials and parts for manufacturing a product before production begins. In a preferred embodiment, the present invention employs a method known as “dice before grind,” in which the wafer **200** is cut before it is grinded to form a plurality of separated dies **300**. At Step **103**, a sawing blade **201** is mounted for a dicing process which cuts the wafer **200** into the plurality of separated dies **300** at Step **104**. Preferably, the sawing blade **201** may partially cut a front side of the wafer **200** to a desired depth.

At Step **105**, the sawing blade **201** is demounted and replaced with a back grinding wheel **202** for grinding a backside of the wafer **200** at Step **107**. Preferably, the back grinding wheel **202** may be a cup wheel which may comprise abrasive grains or abrasive grits, bond material, and pores, and may be manufactured in a variety of grades or structures determined by relative volume percentage of abrasive grains, bond, and porosity. Harder wheels are used in coarse grinding to obtain a longer wheel life. Softer wheels are used in fine grinding to ensure self-dressing ability. In a particular embodiment, the back grinding process is preferred because it is faster and less costly than newer chemical or plasma etching process which have been recently developed. However, some disadvantages may arise such as mechanical stress and heat may be applied during the back grinding process and scratches may also appear. These scratch patterns and depth of the scratches on the surface of the wafer **200** are directly proportional to the size of the grit and the pressure exerted on the wafer **200** during the back grinding process. Further, the depth of the scratches and the backside surface roughness on the semiconductor die **300** have a direct correlation to the strength of the

die **300**, so it is essential that the finished backside surface of the wafer **200** be as smooth or polished as possible.

At Step **106**, one or more layers of adhesive sheets are attached to a carrier **203** by an adhesive applying mechanism, whereby the partially cut wafer **200** will adhere to an adhesive side of the adhesive sheet. In thin semiconductor wafer **200** processes, the wafer **200** is temporarily bonded to a rigid carrier **203** using one or more layers of adhesive sheets upon transferring the partially cut wafer **200** onto the carrier **203** by a transferring mechanism. Preferably, the carrier **203** is made of materials such as by way of example but not limited to, silicon or glass. Glass may be preferred as the carrier **203** due to its thermal and mechanical stability and also chemical resistance. Bonding to and de-bonding from glass carriers **203** can also be monitored since they are transparent. Furthermore, glass carriers **203** can be cleaned and re-used, thus contributing to cost reduction and environmental protection.

In a preferred embodiment, the layer of adhesive sheets may include a thermal tape **204**, an ultraviolet (UV) tape **209**, a dicing tape **206** or the likes. Thermal tape **204**, also known as heat release tape, is used for holding, transfer, carrier masking and protection applications, particularly for semiconductor wafers **200**. The thermal tape **204** may be either single-sided, which has a single layer of heat-peelable adhesive, or double-sided, with one side having a heat-peelable adhesive and the other a base surface adhesive. Both types make use of polyester film as a base. The thermal tape **204** may also be used to hold the semiconductor wafer **200** during cutting or to prevent movement of parts.

Dicing tape **206** is a backing tape used during wafer **200** dicing, the cutting apart of pieces of semiconductor material following wafer **200** microfabrication. The dicing tape **207** holds the pieces of semiconductor, known as die **300**, together during the cutting process, mounting them to a thin metal frame. The dies **300** are removed from the dicing tape **206** later on in the electronics manufacturing process. Further, dicing

tape **206** may be made of polyvinyl chloride (PVC), polyolefin, or polyethylene backing material with an adhesive to hold the die in place. In some cases, dicing tape **206** will have a release liner that will be removed prior to mounting the dicing tape **206** to the backside of the wafer **200**.

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Similar to the thermal tape **204**, the UV tape **210** is preferably double-sided, with the other adhesive side to be attached to the front side of the wafer **200** to form another assembly comprising the wafer **200**, the thermal tape **204**, and the UV tape **210**, such as illustrated in **FIG. 5**. The UV tape **210** is one of many types of dicing tapes **206**, in
10 which its adhesive bond is broken by exposure to UV light after dicing, allowing the adhesive to be stronger during cutting while still allowing clean and easy removal. It is suitable to protect surfaces of the wafer **200** during the back grinding process, and to hold the wafer **200** with a ring frame **208** during the dicing process. Alternatively, the UV tape **209** may also be applicable for various work pieces such as ceramics, glass,
15 sapphire and so on.

In a preferred embodiment, the back grinding wheel **202** grinds the wafer **200** from its backside to a desired thickness, ranging between 0.850 mm to 0.175 mm for example, such as illustrated in Step **107**. At Step **108**, the thickness of the grinded wafer **200** or
20 separated dies **300** are checked before the separated dies proceed to be removed from the carrier at Step **109**, which will be discussed further herein with reference to **FIG. 3** to **FIG. 6**. Steps **110** to **112** illustrates the steps of inspecting the backside and topside of the separated dies using an inspection device before they are sorted out for their respective applications by a sorting mechanism.

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FIG. 2 is a flowchart illustrating a process of dicing before back grinding of the wafer **200**. Firstly, the wafer **200** is partially cut during the dicing process, in which the sawing blade **201** cuts through the front side of the wafer **200** to about 20% of the wafer **200** total thickness. Upon cutting a predetermined number of cuts on the wafer **200**,

preferably transversely across the wafer **200** in two directions perpendicular to each other, so that the cuts form squares on the wafer **200**. Further, the wafer **200** is then adhered to the thermal tape **204** which is attached to the carrier **203** with the front side adhered to one adhesive portion of the thermal tape **204**. The thermal tape **204** will help
5 to prevent the wafer from moving around during the back grinding process. The back grinding wheel **202** will then be used to grind the backside of the wafer **200** to a desired thickness as mentioned above.

FIG. 3 to **FIG. 6** are flowcharts illustrating two techniques for applying one or more
10 adhesive sheets to the semiconductor wafer **200** and carrier **203**. In a preferred embodiment, this technique is applied, preferably after the wafer **200** is partially cut and before it is grinded. Referring to **FIG. 3**, the first technique employs laminating or applying the thermal tape **204** to the carrier **203** which is placed on a chuck table **205**. Once the thermal tape **204** is applied onto the carrier **203**, the wafer **200** is placed on
15 the chuck table **205** with its front side facing upwards from the chuck table **205**, in which the front side of the wafer **200** is then adhered to the other adhesive side of the thermal tape **204** such as shown in **FIG. 3**, forming an assembly comprising of the wafer **200**, thermal tape **204**, and carrier **203**. The assembly is then transferred for the wafer **200** to be grinded, wherein the assembly is flipped over to have the carrier **203**
20 away from and the back side of the wafer **200** exposed to the back grinding wheel **202**.

FIG. 4 illustrates the steps for removing the separated dies **300** from the thermal tape **204** and the carrier **203**. Dicing tape **206** is attached to a metal frame ring **207** also known as a wafer ring, which is then placed on the backside of the separated dies **300**
25 that have been grinded. Once attached, a heated plate **208** is then pressed gently onto the dicing tape **206** to apply adequate pressure onto the separated dies **300** for a predetermined amount of time, for example 30 seconds or less. The heat from the heated plate **208** will weaken the adhesiveness of the thermal tape **204** on the separated dies **300** while maintaining the adhesiveness of the dicing tape **206**, allowing for the

separated dies to be adhered to the dicing tape **206** instead and removed from the thermal tape **204** when the dicing tape **206** and the heated plate **208** are lifted up. Subsequently, the separated dies **300** attached to the dicing tape **206** and metal frame ring **207** will be brought to a next station for subsequent processing and/or polishing.

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In a further embodiment, a second technique as illustrated in **FIG. 5** employs laminating the thermal tape **204** onto the carrier **203** similarly to the first technique. A next layer of adhesive, in the form of the ultraviolet (UV) tape **209**, is applied on top of the thermal tape **204**. **FIG. 6** then illustrates the process of removing the separated dies **300** from the UV tape **209**, similarly to the first technique, whereby the dicing tape **206** is applied onto the separated dies **304** and the heated plate **208** is then pressed on the dicing tape **206** to remove the adhesive of the UV tape **209**. Alternatively, an additional step of UV irradiation onto the UV tape **209** alongside the heated plate **208** may be employed to enhance the removal of the separated dies from the UV tape **209**.

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The present disclosure includes as contained in the appended claims, as well as that of the foregoing description. Although this invention has been described in its preferred form with a degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and that numerous changes in the details of construction and the combination and arrangements of parts may be resorted to without departing from the scope of the invention.

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CLAIMS

1. A method for fabricating semiconductor articles comprising the steps of
partially cutting a wafer (200);
5 applying one or more layers of adhesive sheets onto a carrier (203) that is
transparent and rigid;
transferring the partially cut wafer (200) onto the adhesive sheet on the carrier
(203);
grinding a backside of the wafer (200) to a desired thickness to form separated
10 dies (300); and
transferring the separated dies (300) from the adhesive sheet of the carrier (203)
to an additional layer of adhesive sheet of a frame ring (207) using a heated plate
(208) that has the additional layer of adhesive sheet adhere to the backside of the
separated dies (300);
15 wherein the carrier (203)
supports a pressure exerted by the heated plate (208) during the transfer
of the separated dies (300); and
provides monitoring of a bonding and de-bonding of the separated dies
(300) between adhesive sheets during their transfer.
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2. The method according to claim 1, wherein the layers of adhesive sheet of the
carrier (203) include either
a thermal tape (204) or;
a combination of the thermal tape (204) and an ultraviolet (UV) tape (209).
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3. The method according to claims 1 or 2, wherein the additional layer of adhesive
sheet of the frame ring (207) is a dicing tape (206).

4. The method according to any one of the preceding claims, wherein the wafer (200) is partially cut up to 20% from total wafer (200) thickness.
5. The method according to any one of the preceding claims, wherein the heated plate (208) is pressed against the additional adhesive sheet of the frame ring (207) and the backside of the separated dies (300).
6. A system for fabricating semiconductor articles comprising
 - a sawing blade (201) for partially cutting a wafer (200);
 - 10 an adhesive applying mechanism to apply one or more layers of adhesive sheets onto a carrier (203) that is transparent and rigid;
 - a transferring mechanism to the partially cut wafer (200) onto the adhesive sheet on the carrier (203);
 - 15 a back grinding wheel (202) for grinding a backside of the wafer (200) to form separated dies (300);
 - a frame ring (207) with an additional layer of adhesive sheet; and
 - a heated plate (208) that transfers the separated dies (300) from the adhesive sheets of the carrier (203) to the additional layer of adhesive sheet of the frame ring (207) by having the additional layer of adhesive sheet adhere to the backside of the separated dies (300);
 - 20 wherein the carrier (203)
 - supports a pressure exerted by the heated plate (208) during the transfer of the separated dies (300); and
 - provides monitoring of a bonding and de-bonding of the separated dies (300)
 - 25 between adhesive sheets during their transfer.
7. The system according to claim 6, further comprising a sorting mechanism for sorting the dies upon inspection.

8. The system according to claims 6 or 7, wherein the layers of adhesive sheet of the carrier (203) include either
- a thermal tape (204) or;
 - a combination of the thermal tape (204) and an ultraviolet (UV) tape (209).

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9. The system according to any one of claims 6 to 8, wherein the additional layer of adhesive sheet of the frame ring (207) is a dicing tape (206).

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