

Title
MULTI-CHAMBER CARRIER

Background of the Invention

1. Field of the Invention

The invention relates to a multi-chamber carrier, and more particularly, to a multi-chamber carrier for reducing particle contamination during manufacture, storage or transportation of semiconductor wafers.

2. Description of the Prior Art

Chemical vapor contaminants are known to alter the processes used to manufacture sensitive devices such as microcircuitry. Such chemical vapor contaminants have historically been inadequately addressed. These vapor contaminants originate from a variety of sources, including the enclosures used to protect components from particular contamination. Outgassing of plastics, adhesives, and sealant materials can make the enclosure itself a source of chemical contaminants. In addition, externally produced vapors are capable of contaminating an open closure. Later, when the enclosure contains a sensitive component, such as a semiconductor wafer, these vapors can be re-emitted and contaminate the wafer.

In current practice, the enclosures are designed to be single-chamber system to keep class one environment among semiconductor production. However, chemical outgassing from processed wafers becomes contamination source when they are transferred back to the carrier after fabrication processes. For instance, after a shallow trench isolation (STI) etching process is conducted on a wafer, the self condensation of STI etched wafers byproducts, such as SiCl-based or SiBr-based particles will contaminate subsequent wafers, which lead to partial mask/pattern defects. As contaminant particles produced from outgassing often accumulate on the ceiling of the enclosure and later condense and drop onto the wafers, the top selection of the wafers whose circuit sides face the ceiling and are exposed directly to the contaminant source is typically contaminated and needs to be discarded.

Summary of the Invention

It is an objective of the present invention to provide a multi-chamber carrier for reducing particle contamination during storage of semiconductor wafers.

According to a preferred embodiment of the present invention, a multi-chamber carrier is disclosed. The multi-chamber carrier includes an enclosure having a chamber therein and a first isolation plate and a second isolation plate separating the chamber of the enclosure into a first sub-chamber

for trapping contaminant particles and a second sub-chamber for enclosing a plurality of wafers. The first isolation plate and the second isolation plate preferably include a plurality of slanted holes therein, in which each of the slanted holes has a larger opening facing toward the wafers and a smaller opening facing the ceiling or sidewall of the enclosure.

By using isolation plates to separate the chamber of the enclosure into at least two sub-chambers and forming slanted holes in the isolation plates, the present invention effectively minimizes the opportunity of floating particles entering the chamber where wafers are stored and prevents wafers stored in the chamber of the enclosure from being contaminated.

These and other objectives of the present invention will no doubt become obvious to those of ordinary skill in the art after reading the following detailed description of the preferred embodiment that is illustrated in the various figures and drawings.

Brief Description of the Drawings

Fig. 1 illustrates a perspective view of a multi-chamber carrier according to a preferred embodiment of the present invention.

Fig. 2 illustrates an enlarged view of the slanted holes the isolation plates shown in Fig. 1 and a means for trapping contaminant particles in the sub-chambers according to an embodiment of the present invention.

Fig. 3 illustrates a perspective view of a multi-chamber carrier according to an embodiment of the present invention.

Fig. 4 illustrates an enlarged view of the slanted holes of the isolation plates shown in Fig. 3 and a means for trapping contaminant particles in the sub-chambers according to an embodiment of the present invention.

Fig. 5 illustrates a perspective view of the isolation plates according to an embodiment of the present invention.

Fig. 6 illustrates a perspective view of installing an adsorptive layer onto the multi-chamber carrier of the present invention.

Detailed Description

Referring to Fig. 1, Fig. 1 illustrates a perspective view of a multi-chamber carrier 12 according to a preferred embodiment of the present invention. As shown in Fig. 1, the multi-chamber carrier 12 includes an enclosure 14 having a chamber 16 therein, a first isolation plate 18, and a second isolation plate 20. The first isolation plate 18 and the second isolation plate 20 are positioned with

respect to a neck portion of the enclosure 14 to divide the chamber 16 of the enclosure 14 into a first sub-chamber 22, a second sub-chamber 24, and a third sub-chamber 36. Preferably, the first sub-chamber 22 and the third sub-chamber 36 are formed in the upper region of the chamber 16 for trapping contaminant particles and the second sub-chamber 24 is formed in the lower portion of the chamber 16 for accommodating a plurality of wafers 26. A shelf (not shown) may be installed in the second sub-chamber 24 to support the wafers 26, and the wafers 26 are preferably transferred into the second sub-chamber 24 after being processed through a series of fabrication processes.

It should be noted that the first isolation plate 18 and the second isolation plate 20 include a plurality of slanted holes (not shown) therein, such that as the wafers 26 are placed into the enclosure 14, outgassing results from the processed wafers 26 may cause chemical vapors to flow upward along the sidewall of the enclosure 26 (as the direction of the arrow shown), pass through the slanted holes, and accumulate in the ceiling region of the first sub-chamber 22. As two isolation plates 18, 20 are disposed to divide the interior spacing of the enclosure 12 into the first sub-chamber 22, the second sub-chamber 24 and the third sub-chamber 36, the accumulated chemical vapor or contaminant particles could be trapped inside the first sub-chamber 22 and the third sub-chamber 36 as they fall from the ceiling of the chamber 16. This effectively prevents the wafers 24 enclosed in the second sub-chamber 24 from being contaminated.

Referring to Fig. 2, Fig. 2 illustrates an enlarged view of the slanted holes of the two isolation plates 18, 20 and a means for trapping contaminant particles in the sub-chambers 22 and 36. As shown in Fig. 2, the first isolation plate 18 and the second isolation plate 20 include a plurality of slanted holes 28 therein, in which each of the slanted holes 28 includes two openings 30, 32. The opening 30 facing toward the wafers 26 are preferably larger in diameter, whereas the other opening 32 facing toward the ceiling of the enclosure are smaller in diameter.

By forming a plurality of slanted holes 28 in the first isolation plate 18 and the second isolation plate 20, byproducts or contaminant particles 34 generated from outgassing of processed wafers would first pass through the larger opening 30 and exit from the smaller opening 32 to reach the ceiling of the enclosure 12, and as the particles 34 fall from the ceiling of the enclosure 12, they would fall onto the first isolation plate 18 and be trapped in the first sub-chamber 22 as the smaller opening 32 facing toward the ceiling of the enclosure 12 effectively prevents them from falling back onto the wafers 26.

According to an embodiment of the present invention, the slanted holes 28 of the two isolation plates 18 and 20 may also be formed according to a staggered manner. For instance, even if the particles fall through the slanted holes 28 of the first isolation plate 18, they would still fall onto the second

isolation plate 20 and be trapped inside the third sub-chamber 36 as a result of the staggered arrangement.

Referring to Fig. 3, Fig. 3 illustrates a perspective view of a multi-chamber carrier 42 according to another embodiment of the present invention. As shown in Fig. 3, the multi-chamber carrier 42 includes an enclosure 44 with a chamber 46 therein, a first isolation plate 48, and a second isolation plate 50. The first isolation plate 48 and the second isolation plate 50 together separate the chamber 46 of the enclosure 42 into a first sub-chamber 52, a second sub-chamber 54, and a third sub-chamber 56. The first sub-chamber 52 and the third sub-chamber 56 are formed to trap contaminant particles and the second sub-chamber 54 is formed under the two sub-chambers 52, 56 for enclosing a plurality of wafers 58. In this embodiment, the first isolation plate 48 is positioned with respect to the neck portion of the enclosure 42 and the second isolation plate 50 is formed extending along the sidewall of the enclosure 42 while separating the second sub-chamber 54 and the third sub-chamber 56.

Similar to the aforementioned embodiment, the first isolation plate 48 and the second isolation plate 50 include a plurality of slanted holes (not shown) therein, such that as the wafers 58 are placed into the enclosure 42, outgassing results from the processed wafers 58 would cause chemical vapors to pass through the slanted holes of the second isolation plate 50, rise along the sidewall of the enclosure 42 within the third sub-chamber 56, pass through the slanted holes of the first isolation plate 48, and accumulate in the ceiling region of the first sub-chamber 52. In this embodiment, as the second isolation plate 50 seals the sidewall region of the enclosure 42, the accumulated chemical vapor or contaminant particles could be further prevented from entering the second sub-chamber 54 as they fall from the ceiling of the chamber 46.

Referring to Fig. 4, Fig. 4 illustrates an enlarged view of the slanted holes 60 of the two isolation plates 48, 50 and a means for trapping contaminant particles in the sub-chambers 52, 56. In this embodiment, the first isolation plate 48 and the second isolation plate 50 include a plurality of slanted holes 60 therein, in which each slanted hole 60 has two openings 62, 64. The opening 62 facing toward the wafers 58 are preferably larger in diameter, whereas the other opening 64 facing toward the ceiling or sidewall of the enclosure 42 are smaller in diameter.

By forming a plurality of slanted holes 60 with openings 62, 64 of different sizes in the first isolation plate 48 and the second isolation plate 50, chemical vapor or contaminant particles produced from outgassing of processed wafers 58 would first pass through the larger opening 62 and exit from the smaller opening 64 as they rise from the second sub-chamber 54 and accumulate in the ceiling of the enclosure 42. As the condensed particles 66 fall from the ceiling of the enclosure 42, they would fall onto the first isolation

plate 48 and be trapped in the first sub-chamber 52 as the smaller opening 64 facing toward the ceiling of the enclosure 42 prevents them from falling back onto the wafers 58.

The staggered formation of the slanted holes 60 also traps the particles 66 in the third sub-chamber 56 as they accidentally pass through the first sub-chamber 52. Moreover, as the second isolation plate 50 is formed to enclose the entire interior spacing accommodating the wafers 58, the slanted hole 60 design on the second isolation plate 50 further prevents particles floating in the third sub-chamber 56 from entering the second sub-chamber 54 and contaminate the stored wafers 58.

Referring to Figs. 5-6, Figs. 5-6 illustrate a multi-chamber carrier 72 according to other embodiments of the present invention. As shown in Fig. 5, the multi-chamber carrier 72 includes an enclosure 74 having a chamber 76 therein, a first isolation plate 78 and a second isolation plate 80 separating the chamber 76 into three sub-chambers. The first isolation plate 78 and the second isolation plate 80 could be arranged according to a parallel manner as disclosed in Fig. 1 of the previous embodiment (such as the one shown in Fig. 5), or could also be arranged according to the design shown in Fig. 3. A plurality of slanted holes 82 with two openings 84, 86 of different sizes could also be formed in each of the isolation plates 78, 80.

In Fig. 5, the top surface of either one of the isolation plates 78, 80 is fabricated with a rough surface for trapping fallen particles onto the plate. For instance, as contaminant particles accumulate and fall from the ceiling of the enclosure 74, they are trapped on the surface of either one of the isolation plates 78, 80 and rolling of the particles into the slanted openings 82 is prevented.

In Fig. 6, an adsorptive layer 90 is installed in the chamber 76 of the enclosure 74 for absorbing flowing particles before they fall onto the isolation plates 78, 80. The adsorptive layer 90 could be disposed on the ceiling of the chamber 76 (such as the one shown in Fig. 6) or on the sidewall of the enclosure 74. The preferred material for the adsorptive layer depends on the chemistry of the vapor produced during outgassing. Activated carbon fabric is preferred for organic vapors with medium molecular weight, such as di-octyl-phthalate or silicon oil. For corrosive vapors, a better adsorptive material is activated carbon treated with base. An example is neutralization and removal of benzoic acid vapor by sodium carbonate base. Other adsorptive material can include nano-porous materials such as zeolites and aero-gels.

Overall, the present invention provides a multi-chamber carrier for reducing particle contamination during manufacture, storage, or transportation of semiconductor wafers. The multi-chamber carrier preferably includes an

enclosure having a chamber therein, and a first isolation plate and a second isolation plate for dividing the chamber into three sub-chambers. The arrangement of the first isolation plate and the second isolation plate could be adjusted according to the demand of the product. For instance, the first isolation plate and the second isolation plate could be disposed to sit across the passage between the first sub-chamber and the second sub-chamber for separating the chamber of the enclosure into two sub-compartments. Alternatively, the first isolation plate could sit across the passage between the first sub-chamber and the second sub-chamber while the second isolation plate is formed along the sidewall of the enclosure and the space just on top of the second sub-chamber for enclosing a plurality of wafers inside. The first isolation plate and the second isolation plate also include a plurality of slanted holes therein, in which each of the slanted holes has a larger opening facing toward the wafers and a smaller opening facing the ceiling or sidewall of the enclosure. By using isolation plates to separate the chamber of the enclosure into at least two sub-chambers and forming slanted holes in the isolation plates, the present invention effectively minimizes the opportunity of floating particles entering the chamber where wafers are stored and prevents wafers stored in the chamber of the enclosure from being contaminated.

Those skilled in the art will readily observe that numerous modifications and alterations of the device and method may be made while retaining the teachings of the invention.

Claims

What is claimed is:

1. A multi-chamber carrier, comprising:
 - an enclosure having a chamber therein;
 - a first isolation plate and a second isolation plate separating the chamber of the enclosure into a first sub-chamber for trapping contaminant particles and a second sub-chamber for enclosing a plurality of wafers, wherein the first isolation plate and the second isolation plate respectively comprise a plurality of slanted holes therein.
2. The multi-chamber carrier of claim 1, wherein the first isolation plate and the second isolation plate sit across the passage between the first sub-chamber and the second sub-chamber for separating the chamber of the enclosure into the first sub-chamber and the second sub-chamber.
3. The multi-chamber carrier of claim 1, wherein the first isolation plate sits across the passage between the first sub-chamber and the second sub-chamber and the second isolation plate extends along the sidewall of the enclosure and the top of the second sub-chamber for enclosing the wafers.
4. The multi-chamber carrier of claim 1, wherein the slanted holes of first isolation plate and the second isolation plate are arranged according to a staggered manner.
5. The multi-chamber carrier of claim 1, wherein the top surface of the first isolation plate or the second isolation plate comprises a rough surface.
6. The multi-chamber carrier of claim 1, further comprising an adsorptive layer disposed on ceiling or sidewall of the enclosure.
7. The multi-chamber carrier of claim 1, further comprising a shelf for accommodating the wafers.
8. The multi-chamber carrier of claim 1, wherein each of the slanted holes comprises a larger opening and a smaller opening.
9. The multi-chamber carrier of claim 8, wherein the larger opening of the slanted hole faces the wafers and the smaller opening of the slanted hole faces the ceiling of the enclosure.
10. The multi-chamber carrier of claim 1, further comprising a third sub-chamber formed between the first isolation plate and the second isolation plate for trapping contaminant particles.