

A COMPARTMENT FOR MAINTAINING
A CLEAN PRODUCTION ENVIRONMENT

5 Field of the invention

The invention relates to a compartment for carrying out processes which require an environment with a relatively high degree of cleanliness, such as processes for assembling semiconductor devices and integrated circuit
10 packages.

Background and prior art

Traditionally, large clean rooms with cleanliness levels of below 10,000 or
15 100,000 particles 0.5 microns or larger per cubic meter of air (hereinafter referred to as class 10,000 and 100,000 respectively) is required to provide the clean air needed for the assembly, packaging and testing of integrated circuit packages. Electrical risers are commonly installed in the clean room to supply the necessary electrical and gas supplies to the semiconductor
20 producing equipment.

Such clean rooms are very expensive to set up and to maintain. Due to increased automation of manufacturing and assembly processes, it would be advantageous to reduce the size of the environment wherein the clean air is
25 maintained so as to minimize the set-up and maintenance costs required for a traditional clean room.

In US Patent No. 4,934,920 relating to "An Apparatus for Producing Semiconductor Device", an apparatus is described to provide a more dust-
30 free environment for the production of semiconductor devices. The apparatus comprises a dust-proof cover which shields the semiconductor chips and the lead frame from ambient air and a dust collecting means for sucking air out of the dust-proof cover to suck dust from the interior of the dust-proof cover. Whilst it serves to remove dust generated by the discharge of dust from the

molding process, it does not solve the problem of performing the whole manufacturing process, which may include a whole production line involved in the semiconductor assembly process, in an environment that is cleaner than its surroundings.

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Summary of the invention

It is an object of the invention to seek to mitigate the disadvantages of the prior art.

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Accordingly, the invention provides a compartment having a space segregated from air outside the compartment and is capable of storing a production apparatus, comprising panels defining the space, an air transmission passage channeling air into the space, air filtering means disposed between the air transmission passage and the space to cleanse air entering from the air transmission passage, and an air outlet to allow air to be expelled from the space, whereby the compartment is adapted continuously to maintain air within the compartment cleaner than the air outside the compartment.

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Using the invention, it is possible to provide a compartment wherein one or more production apparatuses in which a manufacturing process is carried out may be segregated from the surrounding environment. Means may be provided to maintain the space within the or each compartment at a level of cleanliness that is higher than the surrounding environment so as to obviate the need for a traditional large clean room to carry out the manufacturing processes.

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It will be convenient to hereinafter describe the invention in greater detail by reference to the accompanying drawings which illustrate one embodiment of the invention. The particularity of the drawings and the related description is not to be understood as superseding the generality of the broad identification of the invention as defined by the claims.

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Brief description of the drawings

The drawings represent a preferred embodiment of the invention by way of illustration only, wherein:

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Figure 1 is an isometric view of a compartment according to the preferred embodiment of the invention.

Figure 2 is a front elevation view of the compartment of Figure 1.

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Figure 3 is a side elevation view of the compartment looking from direction A of Figure 2.

Detailed description of preferred embodiment of the invention

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Figure 1 is an isometric view of a compartment 10 according to the preferred embodiment of the invention. Figure 2 is a front elevation view of the compartment of Figure 1. The compartment 10 includes panels 16 to segregate the air inside the compartment 10 from the surrounding environment. At the front of the compartment 10, there is a top access panel 12 and a bottom access panel 14 to access a production apparatus (not shown) which is houseable or storable within a space 32 for such apparatus within the compartment 10.

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Where it is desired to place a plurality of compartments 10 adjacent to one another to accommodate a production line, an opening 18 can be included on one or both of the side panels 16 for transfer of processed material, such as lead frames for assembling integrated circuit packages, from one production apparatus to another, housed in respective adjacent compartments 10.

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At the top (as viewed) of the compartment 10, there is an air transmission passage, which may be in the form of a ventilation duct 20, to introduce air from an air-generating means, such as an air conditioner, into the space 32 in the compartment 10. Alternatively, a blower 29 may directly draw air from the

surrounding environment. It is thus preferred, but not necessary, that the air introduced by the air-generating means is substantially clean. The compartment 10 includes a blower 29 and air filter 30 (see Figure 3) to purify air entering the space 32 from the ventilation duct 20. The air filter is
5 preferably a HEPA filter of a grade of class 1,000 or less.

Whilst clean air is introduced into the compartment 10, it is necessary for air within the space 32 to be expelled from the compartment 10, due to contamination from the manufacturing process and other factors. Thus, an air
10 outlet, such as a ventilation outlet 22, for air to enter it through a return path 23, is implemented to allow air within the space 32 to escape while at the same time, more air is being fed into the space 32 via the ventilation duct 20.

Additionally, various trunkings can be included to allow cabling links to the production apparatus within each compartment 10. For example, an electrical
15 trunking 21 may be included to run electrical cables along the top of the compartment and into the production apparatus in the compartment 10. There may also be various gas ducts 24 to channel gases generally used in a semiconductor manufacturing process into the production apparatus, such as
20 compressed air or nitrogen.

Optionally, display means such as a liquid crystal display (LCD) monitor 26 may be included to the compartment 10 and mounted onto a mounting arm 28. The display means 26 may be used to display production parameters,
25 production progress and/or other information to monitor the production process. The mounting arm 28 preferably includes at its distal end a roller 32 and a guide rail 34 (see Figure 3) so that the display means 26 is movable to various positions along a production line of similar compartments.

30 Figure 3 is a side elevation view of the compartment looking from direction A of Figure 2. In particular, sectional views of the ventilation duct 20, ventilation outlet 22 and cable trunking 21 are shown.

It will be understood that air from the ventilation duct 20 is drawn into the space 32 within the compartment 10 by means of a blower 29. Located between the blower 29 and the space 32 is an air filter 30 that filters air that is blown into the space 32. The air filter 30 seeks to maintain the cleanliness of the air inside the space 32 to preferably class 1,000 or better, i.e. less than 1,000 particles 0.5 microns or larger per cubic meter of air. The air in the space 32 leaves the space 32 into the ventilation outlet 22 through a return path 23 that is formed between the ventilation outlet 22 and the space 32. Due to the pressure formed in the space 32 by the blower 29 forcing air into the space 32, the air would tend to escape through the return path 23 into the ventilation outlet 22 owing to a pressure differential between the ventilation duct 20 and the ventilation outlet 22. Nevertheless, to increase the air-flow pressure differential, it is possible to include a suction fan (not shown) at a point along the ventilation outlet 22 to force air out of the space 32, via the ventilation outlet 22. The suction fan may be in the ventilation outlet 22 or at its entry or exit.

As regards the display means 26 mounted on the mounting arm 28, there is a roller 32 mounted on the distal end of the mounting arm 28, which is guided along the side of the compartment 10 by a guide rail 34. This function is most useful when a plurality of compartments are arranged side-by-side to form a production line. When the guide rail 34 of each adjacent compartment is aligned and interconnected with that of an adjacent one, the mounting arm 28 and display means 26 may be slid from one compartment to another by an operator, depending on the location of the operator, along the production line. A communications cable linking the display means 26 to a computer processing information for display is provided to extend along the plurality of compartments covered by the display means 26.

When a number of similar compartments 10 are aligned side-by-side to form a production line, and suitably interconnected, the openings 18 should also be aligned such that processed material may be passed from a production apparatus within one compartment to a production apparatus in an adjacent compartment. A typical production line for integrated circuit packages would

include one or more die-bonders, snap-cure ovens, buffers, strip-based plasma systems, wire-bonders, molding machines, trim and form machines, and strip testers.

- 5 Each component in the production line may preferably be housed in a separate compartment 10 to maintain the clean processing environment within each space 32. A compartment 10 has interengagement means whereby it may be connected with a similar compartment in a manner to provide that each space 32 is segregated from outside (ambient) air, and to
- 10 that end the ventilation ducts 10 and outlets 22 of adjacent interconnected compartments 10 may be releasably engageable as by a push-fit connection. Conveying means (not shown) such as rollers for transporting lead frames may be included to automate the transfer of processed material from one apparatus to another, the processed material passing through the openings
- 15 18. The separation of production of each manufacturing component into a separate compartment 10 has the advantage of modularity, so that different components in the production line may be mixed and matched according to manufacturing requirements with minimal re-orientation of production equipment or machines. A modular production line is thereby provided.

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The panels 12, 14, 16 of the compartment 10 may be made of fiberglass or other suitable material. The material may be opaque with a selected transparent viewing area, or wholly transparent, in which event the processes being carried out can be more easily monitored.

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- It would be appreciated that the invention provides the incorporation of embedded facilities in the form of a compartment with a controlled environment for one or more equipment in the production line. By enclosing the equipment with a compartment that is self contained with clean dry air,
- 30 electrical, gas and communication network supplies, the cleanliness level required of the rest of the room wherein the equipment is held can be reduced.

The invention described herein is susceptible to variations, modifications and/or additions other than those specifically described and it is to be understood that the invention includes all such variations, modifications and/or additions which fall within the spirit and scope of the above description.

What is claimed is:

1. A compartment to house at least one production apparatus for performing at least one production task on a workpiece, the compartment
5 comprising:
 - panels defining a space segregated from an environment external to the compartment;
 - an air transmission passage configured to channel air into the space;
 - 10 an air filtering arrangement disposed between the air transmission passage and the space to cleanse the air channeled from the air transmission passage so that the air within the compartment is continuously maintained cleaner than air outside the compartment;
 - an air outlet arrangement to permit the air to be expelled from the
15 space; and
 - a transport arrangement configured to permit the compartment to be detachably coupled directly to at least one adjacent second compartment to form a production line for the workpiece.
- 20 2. The compartment of claim 1, wherein the space of the compartment is sized to accommodate the production apparatus.
3. The compartment of claim 1 or claim 2, wherein the transport arrangement includes a conveying arrangement configured to convey the
25 workpiece from the space to the adjacent second compartment.

4. The compartment of any one of the preceding claims, wherein the panels include at least one opening aligned with a respective second opening of the adjacent second compartment to convey the workpiece
5 from the space to the adjacent second compartment.

5. The compartment of any one of the preceding claims, further comprising:

an access arrangement configured to permit access to the
10 production apparatus to permit the production apparatus to be interchanged with at least one second production apparatus without reorienting the compartment within the production line.

6. The compartment of claim 5, wherein the access arrangement
15 includes an access panel.

7. The compartment of any one of the preceding claims, further comprising:

a display arrangement to permit an operator to monitor at least
20 one of production parameters, production process and production process information.

8. The compartment of claim 7, further comprising:

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a mounting arrangement slideably coupled to one of the panels along a width of the compartment, the display arrangement being mounted to the mounting arrangement.

5 9. The compartment of claim 8, wherein the mounting arrangement is operable to be slid to the adjacent second compartment to permit the display arrangement to be slid over an entire width of the production line.

10 10. The compartment of any one of the preceding claims, further comprising:

an electrical trunking arrangement to supply electricity to the production apparatus within the compartment.

15 11. The compartment of any one of the preceding claims, further comprising:

at least one gas duct to supply an associated gas to the production apparatus within the compartment.

20 12. The compartment of any one of the preceding claims, wherein the filter arrangement maintains a cleanliness of the air within the space at least at class 1,000.

13. A production line for performing a plurality of production tasks on a workpiece, the production line comprising:

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a plurality of adjacent compartments detachably coupled to one another, each of the compartments housing at least one production apparatus to perform at least one of the production tasks on the workpiece, each of the compartments including:

5 panels defining a space segregated from an environment external to the compartment;

 an air transmission passage configured to channel air into the space;

 an air filtering arrangement disposed between the air transmission
10 passage and the space to cleanse the air channeled from the air transmission passage so that the air within the compartment is continuously maintained cleaner than air outside the compartment;

 an air outlet arrangement to permit the air to be expelled from the space; and

15 a transport arrangement configured to permit the compartments to be detachably coupled directly to one another to form the production line.

14. The production line of claim 13, wherein the transport arrangement of each of the compartments includes a conveying arrangement
20 configured to convey the workpiece from the space to an adjacent compartment.

15. The production line of claim 13 or claim 14, wherein the panels of the compartments respectively include at least one opening mutually

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aligned to convey the workpiece between the compartments in the production line.

16. The production line of any one of claims 13 to 15, wherein each of
5 the compartments further includes an access arrangement configured to permit access to the production apparatus to permit the production apparatus to be interchanged with at least one second production apparatus without reorienting the compartments within the production line.

10 17. The production line of any one of preceding claims, wherein each of the compartments further includes a display arrangement to permit an operator to monitor at least one of production parameters, production process and production process information.

15 18. The production line of claim 17, wherein each of the compartments further includes a mounting arrangement slideably coupled to one of the panels along a width of the compartment, the display arrangement being mounted to the mounting arrangement.

20 19. The production line of claim 18, wherein the mounting arrangement is operable to be slid between the compartments to permit the display arrangement to be slid over an entire width of the production line.

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20. The production line of any one of claims 13 to 19, wherein the production apparatus includes at least one of a die-bonder, a snap-cure oven, a butter, a strip-based plasma system, a wire-bonder, a molding machine, a trim and form machine, and a strip tester.