United States Patent [19]

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[54] **INTEGRATED CIRCUIT HAVING A PRE-ATTACHED CONDUCTIVE MOUNTING MEDIA AND METHOD OF MAKING THE SAME**

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[73] Assignee: **Fairchild Semiconductor Corporation**, Cupertino, Calif.

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[51] **Int. Cl.**[4] **H01L 39/02**

[52] **U.S. Cl.** **357/80**; 228/123; 437/180

[58] **Field of Search** 357/74, 81, 82, 70, 357/80; 228/123, 159, 160, 188; 29/590, 591, 589, 583, 739, 740; 428/620, 621, 624, 625, 626, 634, 673

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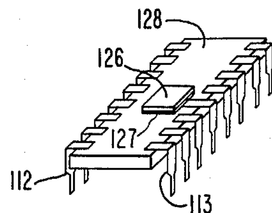
Assistant Examiner—Frank González
Attorney, Agent, or Firm—Stephen J. Phillips; David H. Carroll; James M. Heslin

[57] **ABSTRACT**

A semiconductor wafer having a plurality of integrated circuits is provided. One surface of the wafer includes a plurality of electrical contacts on the circuits which are subsequently attached to leads. The other surface of the wafer is provided with a conductive tape. The wafer is cut, e.g., sawed, resulting in each individual circuit having a pre-attached conductive mounting media. The individual circuits can then be attached to a substrate through the conductive mounting media. Other embodiments are disclosed.

19 Claims, 11 Drawing Figures



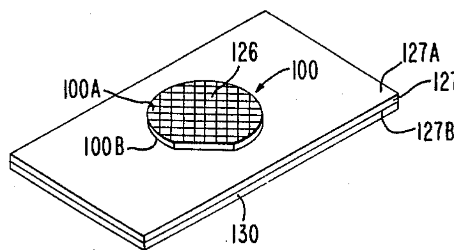


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FIG. 1

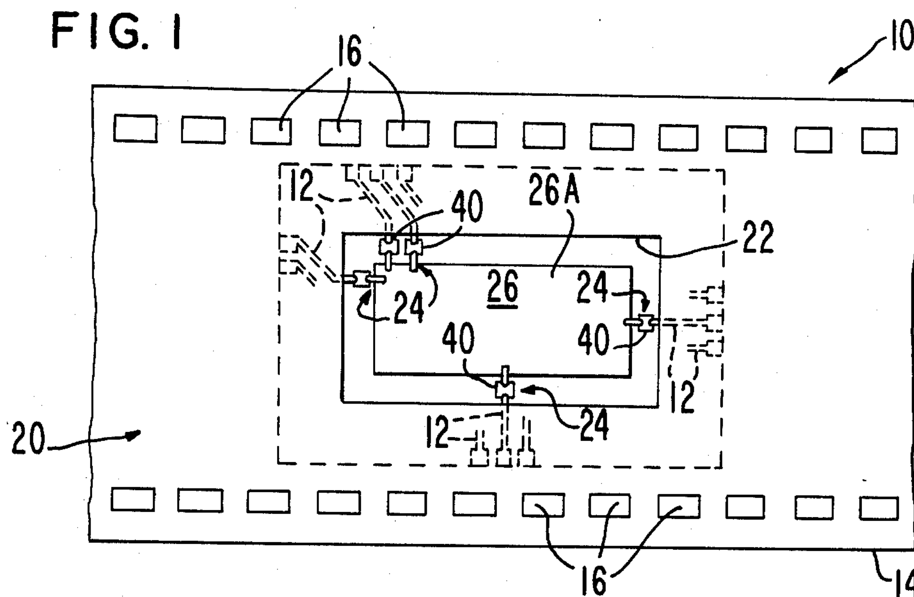


FIG. 2A

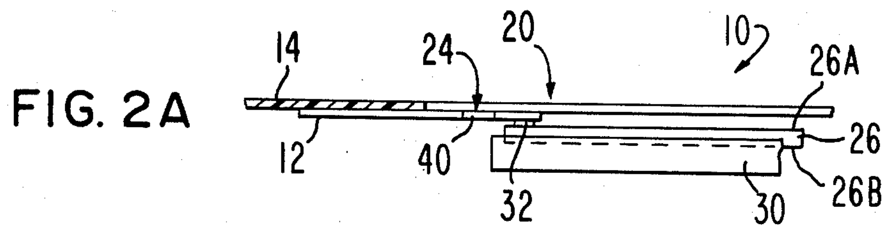


FIG. 2B

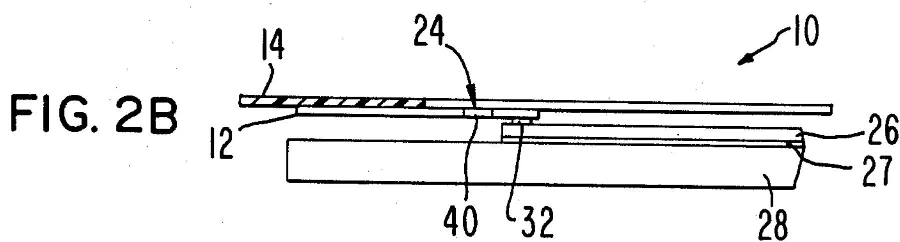


FIG. 2C

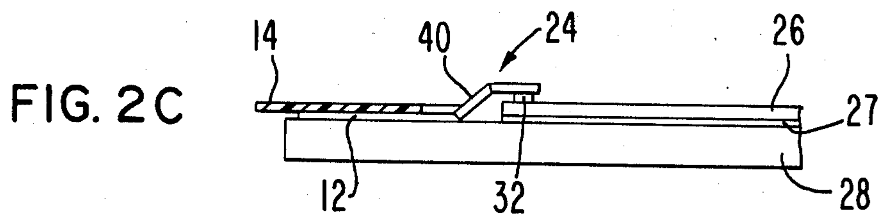
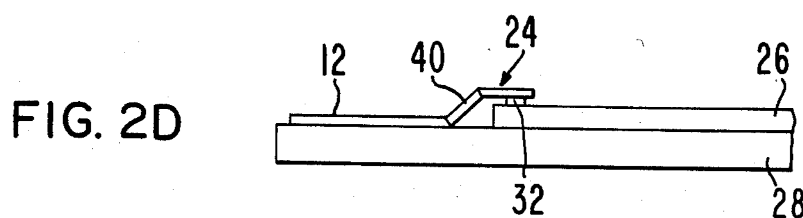


FIG. 2D



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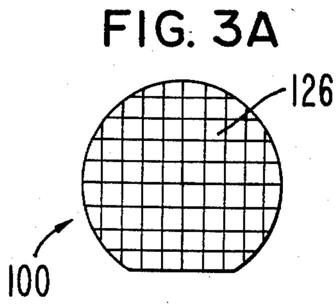

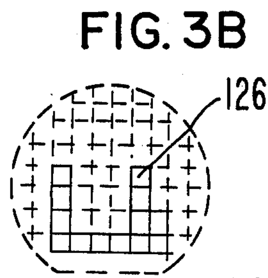

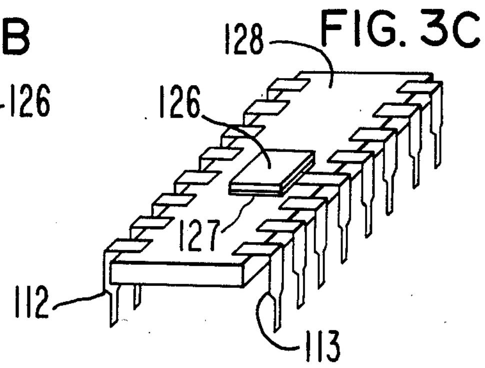

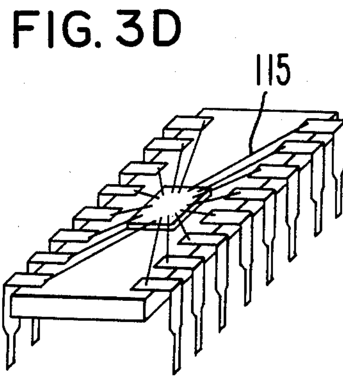

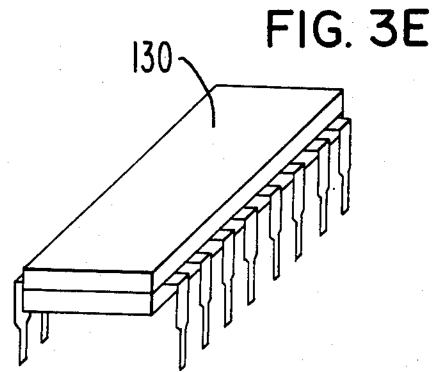

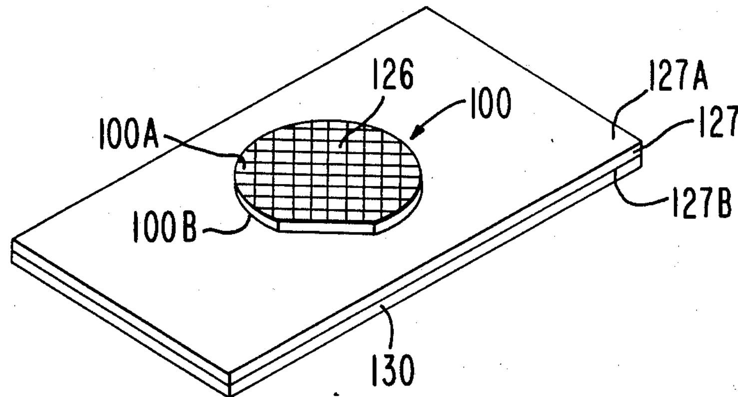

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INTEGRATED CIRCUIT HAVING A PRE-ATTACHED CONDUCTIVE MOUNTING MEDIA AND METHOD OF MAKING THE SAME

BACKGROUND OF THE INVENTION

The present invention relates generally to packages for integrated circuits, and more particularly to such packages in which a surface of the integrated circuit is provided with a pre-attached conductive mounting media.

In the manufacture of integrated circuits, wafers containing many separate integrated circuits are fabricated and then cut into individual circuits, often individually referred to as die. Each die is individually packaged, using any one of a variety of known techniques. During packaging, electrically conductive leads are attached to electrical contacts of the die by well known techniques, such as wire bonding or tape automated bonding. A particularly desirable lead attachment technique is disclosed in my copending application of Ser. No. 365,686, filed Apr. 5, 1982, now U.S. Pat. No. 4,390,598, entitled "Lead Format For Tape Automated Bond", assigned to the assignee of the current application and hereby incorporated by reference. After the assembly of the die and the conductive leads is completed, the resulting assembly is then usually encapsulated in epoxy or some other enclosure for protection.

Referring more particularly to the typical die, one surface of the die includes a plurality of the electrical contacts to which these leads are attached while the opposing surface of the die is generally conductively bonded to a substrate by conventional means. For example, as described in my previously mentioned copending patent application, one technique is to employ a thin layer of conductive polymide paste placed on the substrate and then apply heat to cure the paste and attach the die to the substrate. Thus, although the electrical connections necessary on one side of the die can be made simply and in an automated fashion, the steps involved in attaching the die to the substrate, often referred to as die-attach, are not easily automated. In this connection, it has been found that, in addition to presenting risk of failure, the steps of dispensing and applying liquid or paste are difficult to automate.

Accordingly, it is a general object of this invention to provide an improved die-attach method and structures made by such method.

Another object of the present invention is to provide such a die-attach method which avoids problems associated with the steps involved in the use of paste or liquid die-attach media.

Another object of this invention is to provide a die-attach method which can be automated.

SUMMARY OF THE INVENTION

In one form of the invention, a method is provided for attaching a conductive mounting media to an integrated circuit. The method includes a step of providing a semiconductor wafer including a plurality of integrated circuits therein. The wafer has a pair of opposing major surfaces with one of the surfaces including a plurality of electrical contacts for each of the integrated circuits. The method includes the step of attaching the other of the major surfaces of the wafer to a first surface of an electrically conductive tape. The method includes the step of separating individual ones of the integrated circuits, wherein each of the individual ones includes the conductive mounting media attached thereto with the media comprising a portion of the electrically conductive tape.

BRIEF DESCRIPTION OF THE DRAWINGS

For better understanding of the invention, reference may be had to the following description, taken in conjunction with the accompanying drawings, wherein:

FIG. **1** is a view of a tape comprising a carrier film having leads positioned above an integrated circuit prior to attaching the integrated circuit to a substrate.

FIGS. **2**A–2D are partial elevational views illustrating one form of the present invention in which the integrated circuit shown in FIG. **1** is attached to the substrate.

FIGS. **3**A–3E are schematic views showing one form of integrated circuit assembly sequence to which the present invention relates.

FIG. **4** is an isometric view showing one form of the present invention in which an electrically conductive tape is attached to a semiconductor wafer.

DETAILED DESCRIPTION

Referring to FIG. **1**, a tape **10** comprises a plurality of electrically-conductive leads **12** laminated to the underside (as viewed in FIG. **1**) of a carrier film **14**. The leads **12** are typically formed from copper, and conventional circuit board processes are used to etch a copper layer laminated to the film **14** into the desired pattern of leads. The film **14** is typically formed from glass fiber or a synthetic polymer. It is desirable that the polymer be heat and chemical resistant to withstand the various processing steps required in formation of the tape and connection of the leads **12** to electrical contacts on a surface **26**A of an integrated circuit **26**. Preferred polymers include Mylar° (polyester), and polyvinyl chloride. Particularly preferred are polyimides. The film **14** includes sprocket holes **16** along both edges for use in advancement and registration of the film.

The tape **10** includes a plurality of frames **20** defined by a central opening **22** penetrating the carrier film **14** at a location typically mid-way between the edges. The frame **20** is further defined by the plurality of leads **12** which encompass the periphery of the opening **22**, each extending inward a short distance into the opening. As will be described in more detail hereinafter, the portion **24** of each lead **12** which extends into the opening **22** is eventually bonded to the electrical contacts of integrated circuit die **26** when the die is brought into position beneath the opening **22**.

Referring to FIGS. **2**A–2D, the opposing surface **26B** of the integrated circuit die **26** is attached to a substrate **28** in a multi-step operation, as will now be described.

Initially, the integrated circuit **26** is held in a wax form **30**, as illustrated in FIG. **2**A. The integrated circuit **26** is brought into contact with the tape **10** at the appropriate frame **20** so that the outer portions **24** of the leads **12** contact bumps **32** formed on the upper surface **26**A (as viewed in the Drawings) of the circuit **26**. Although only a single lead **12** and bump **32** are illustrated in FIGS. **2**A–2D, it is to be understood that the surface **26**A of the integrated circuit **26** includes a plurality of bumps **32** corresponding to the number of electrical contacts in the particular integrated circuit, and that for the most part each bump **32** will have a corresponding electrical lead **12** to which it will be attached. The bumps **32** are typically formed from a gold/tin alloy

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which may be thermally bonded to the leads **12** in a conventional manner, typically by thermocompression, ultrasonic, eutectic or reflow solder techniques. The heat from the bonding will melt the wax form **30** and allow the tape **10** to carry the die **26** upward and away.

After the contacts on the surface **26A** of the integrated circuit **26** have been bonded to the leads **12**, and before the circuit is attached to the substrate **28** in accordance with one form of the present invention, the circuit may be tested by a conventional techniques. Testing at this stage of assembly is particularly convenient since the circuits are still mounted on the tape and may be sequentially screened as part of the assembly procedure. Moreover, the circuits have been bonded to the lead frame and any damage which may have resulted from such handling and bonding will be uncovered in the screening.

After the integrated circuit **26** has been tested and found functional, the surface **26B** of the circuit **26** is attached to the substrate **28** to form a conventional package. Exemplary materials for the substrate **28** include electrical insulators, e.g., aluminum oxide, beryllium oxide, as well as electrical conductors, e.g., metals and alloys, such as copper alloys, KOVAR TM. As shown in FIG. **2B**, the circuit **26** is brought into position so that it lies adjacent the proper position on the substrate **28** and is attached thereto. In accordance with one form of the present invention, the surface **26B** of the integrated circuit **26** is provided with a pre-attached conductive mounting media **27** which is preferably in the form of a solid material. The media **27** preferably has a thickness from about 0.5 mils to 3.0 mils. Preferred materials for the conductive mounting media **27** include polymides, particularly polymides having a noble metal, e.g., silver, content such that the media **27** exhibits, or can be altered to exhibit an electrical resistivity of less than 100 m ohm/square.

Then, the entire assembly shown in FIG. **2B** is heated and, if desired, pressure is applied to encourage attachment of the integrated circuit **26** to the substrate **28**. For example, for a conductive polymide media **27**, heating may be in the range of about 250° C. to about 350° C. and applied pressure may be in the range of about 20 to about 40 gm/cm^2.

Conveniently, before the assembly of the substrate **28** and the die **26** is heated, the leads **12** will be formed downward and attached to the substrate **28**, as illustrated in FIG. **2C**. The outer portions of the leads **12** are attached to the substrate **28** by conventional means, typically using gold-tin reflow techniques. It is preferred to form the leads **12** and attached both the leads and the die **26** to the substrate **28** in a single step, although the order and manner of attaching the various components is not critical. Stretch loops **40** are provided in the inner portions **24** of each lead **12** to accommodate the downward movement of the leads **12** when attached to the substrate. Particularly preferable is the stretch loop configuration described in my previously referred to copending application.

After the outer portions **12** have been attached to the substrate **28**, the carrier film is excised, leaving the assembly shown in FIG. **2D**.

An advantage of the use of the pre-attached conductive mounting media as described above is that the conventional die-attach steps dealing with liquid or paste are unnecessary. Thus, in combination with the tape automated bond of my previously preferred application, a packaging assembly is provided which is highly automated.

The pre-attached conductive mounting media structure and method of the present invention are generally applicable to integrated circuit packaging.

For example, in the conventional integrated circuit assembly sequence shown schematically in FIGS. 3A–3E, the integrated circuit can be provided with pre-attached conductive mounting media in accordance with the present invention. More particularly, as shown in FIG. 3A, a semiconductor wafer **100** is provided and includes a plurality of integrated circuits **126** therein. After testing the individual circuits **126**, the circuits are separated, e.g., through sewing, as shown in FIG. 3B. Next, the individual circuits **126** are attached through their conductive mounting media **127** to a substrate **128** having a plurality of electrical contacts **112**, **113**, as shown in FIG. 3C. Next, leads **115** are provided for connecting the contacts **112**, **113** to the corresponding contacts of the integrated circuit **126**, as shown in FIG. 3D. Finally, the assembly is provided with encapsulation **130**, as shown in FIG. 3E.

In accordance with one form of the present invention, a preferred manner of providing the pre-attached conductive mounting media **127** shown in FIG. 3C is to provide the media **127** to the rear surface of the wafer **100** such that, after the separating step shown in FIG. 3B, each individual circuit then includes the pre-attached conductive mounting media **127**.

More particularly, as shown in FIG. **4**, the rear major surface **100B** of the wafer **100** (previously shown in FIG. 3A) is attached to a first major surface **127A** of conductive mounting media **127** which is preferably in the form of a tape. Preferably, for ease of handling, the major surfaces **127A**, **127B** are each greater in area than the major surface **100B** of the wafer **100**. For ease of handling, it is desirable to have the other major surface **127B** of the tape removably attached to a carrier film **130**. Exemplary carrier films include materials such as polyolefine and poly-vinyl-chloride. Of course, the conductive tape **127** should exhibit a release characteristic wherein it is relatively more strongly attached to the wafer **100** and less strongly attached to the carrier film **130**. When the structure shown in FIG. **4A** is separated, e.g., sawed, each of the resulting integrated circuits **126** are provided with conductive mounting media attached thereto. That is, the remaining portion of conductive tape **127** is the conductive mounting media.

In the attaching of the tape **127** to the wafer **100**, if the tape is a conductive polymide, it is generally desirable to apply sufficient heating to encourage a strong attachment as well as to cause the polyimide to develop a desired electrical conductivity. Typically, this heating may be in the range of about 250° C. to about 375° C.

While the present invention has been described with reference to specific embodiments thereof, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from the invention in its broader aspects. It is contemplated in the appended claims to cover all variations and modifications of the invention which come within the true spirit and scope of my invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A semiconductor body comprising:

an integrated circuit obtained from a semiconductor wafer, wherein a major surface of said integrated

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