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US 5923958 A **US 5818094 A**

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(54) Abstract Title
Improvements in or relating to image sensor packaging

(57) An image sensor device comprises an image sensor chip (12), including an image sensor array (22) formed on a top surface thereof, mounted on a substrate (10) and encapsulated by means of a dam wall (14) formed on the substrate and surrounding the periphery of the sensor chip and having a transparent lid member (16) affixed to the upper edges of the dam wall. A barrier (20) is formed on the surface of the chip, extending along at least a substantial part of at least one side of the sensor array between the sensor array and the dam wall. Preferably, the barrier is formed with a height of at least three microns and surrounds the sensor array. The barrier may be formed during fabrication of the sensor chip. Where the sensor chip is a colour image sensor including a mosaic of colour filter material overlying said sensor array, the barrier may be formed from the colour filter material simultaneously with the formation of the mosaic. The barrier prevents resin bleeding from the dam wall onto the surface of the sensor array.

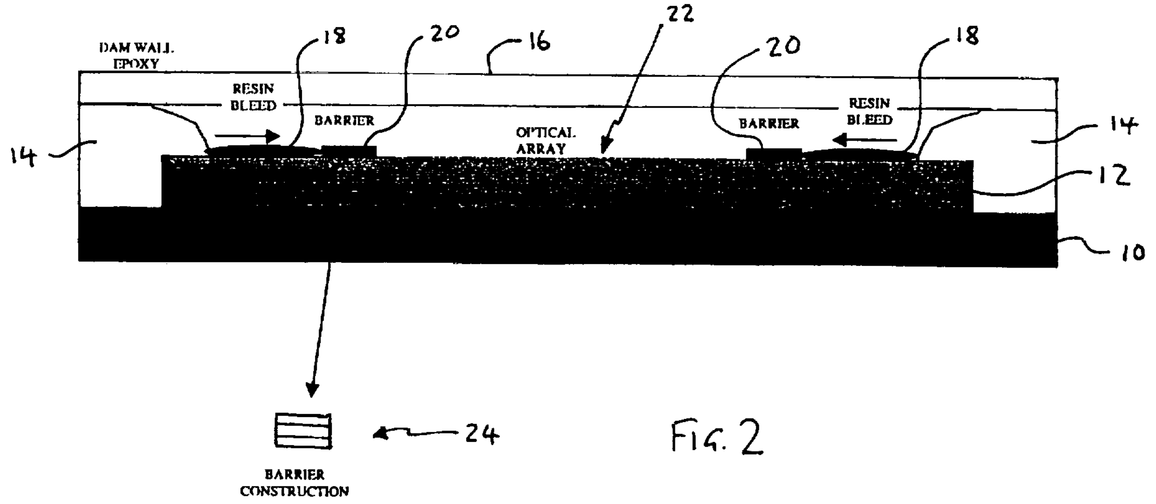

Fig. 2

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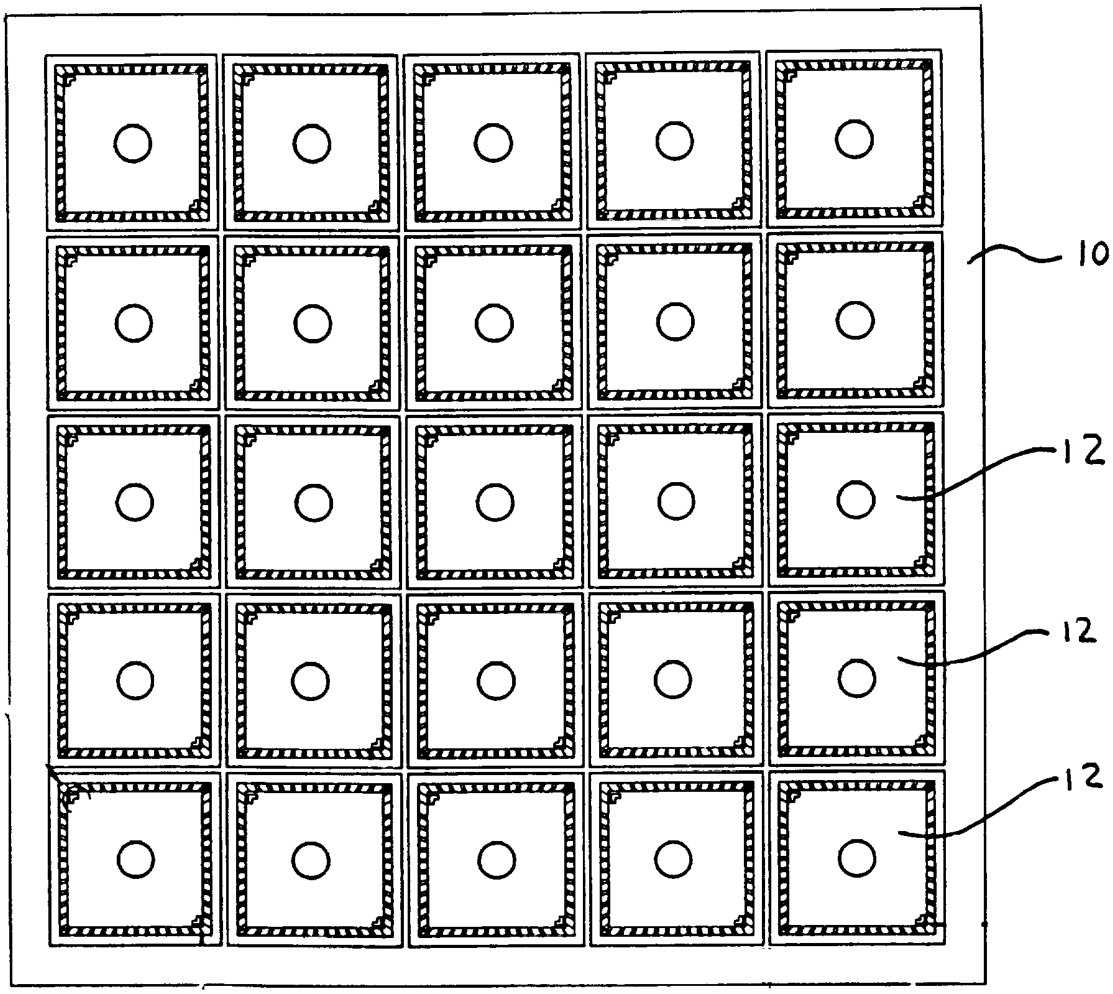

FIG. 1

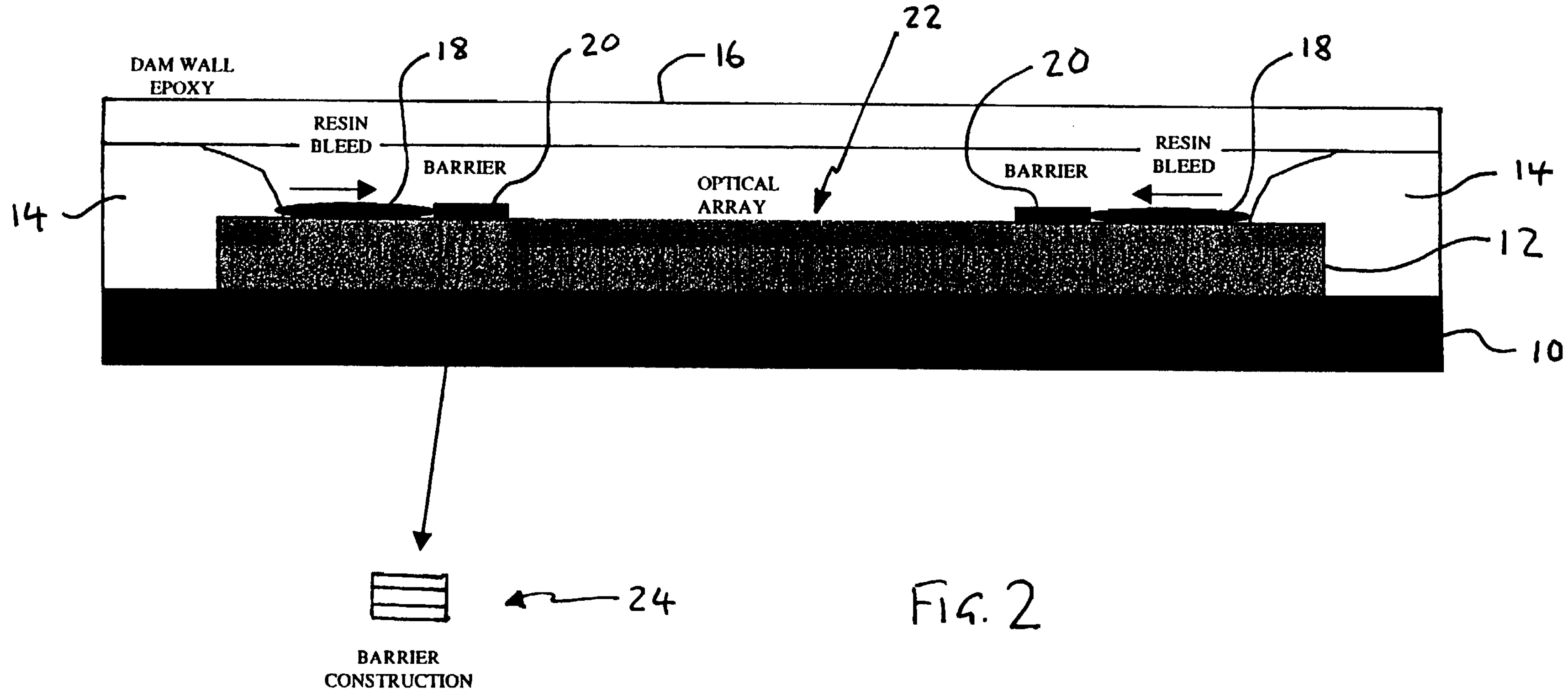
DAM WALL EPOXY
RESIN BLEED
BARRIER
OPTICAL ARRAY
BARRIER
RESIN BLEED
18
20
16
22
20
18
14
14
12
10
24
BARRIER CONSTRUCTION

FIG. 2

"Improvements in or relating to Image Sensor Packaging"

The present invention relates to the packaging of integrated circuits for use as image sensors ("image sensor chips").

Most types of integrated circuits ("chips") require "packaging" to encapsulate the sensitive chips and provide mechanical protection during shipping, assembly and subsequent use. Optical chips such as image sensors are unusual in that it is necessary for their packaging to include a transparent window to admit or release light. In the case of image sensors, the window allows light to impinge upon the optical sensor array which forms part of the chip. The transparent window, or lid, is commonly formed from glass.

Optical devices of this type are also unusually difficult to manufacture because of stringent requirements for cleanliness. Any foreign material impinging on onto the surface of the sensor array can cause image degradation leading to rejection of the device and hence to higher component cost due to reduced manufacturing yield.

Conventionally, image sensor packages are formed by mounting a plurality of sensor chips in a rectangular array on a substrate tile (typically of ceramic material). After wire bonding, a lattice of "dam" walls is written in liquid epoxy between the adjacent chips, so that each chip is surrounded on all four sides by a wall of epoxy material. A glass sheet is then placed on the top surface, adhering to the tops of the dam walls and encapsulating each chip in isolation from the surrounding chips. The whole assembly is then baked to harden the epoxy walls and then cut along the lines of the walls between adjacent sensors to produce a plurality of individual, encapsulated sensor devices.

This technique is very cost effective, but has a significant disadvantage. Resin can bleed out of the dam wall material when in the liquid state, running by capillary action onto the chip surface and, in some instances, onto the critical image sensing array area, causing unacceptable image blemishes. Accordingly, the manufacturing yield is reduced and the unit cost of the sensor devices is increased.

This problem applies to both monochrome and colour sensors, the latter having a thin layer (typically less than 2 microns) of colour filter material (the "mosaic") covering the sensitive array area.

It is an object of the present invention to provide improved methods for packaging image sensors, and improved image sensors formed thereby, in which the above mentioned problem is obviated or mitigated.

In accordance with a first aspect of the present invention, there is provided a method of manufacturing an image sensor device of the type comprising an image sensor chip, including an image sensor array formed on a top surface thereof, mounted on a substrate and encapsulated by means of a dam wall formed on the substrate and surrounding the periphery of the sensor chip and having a transparent lid member affixed to the upper edges of said dam wall, wherein the method includes forming a barrier on the surface of said sensor chip and extending along at least a substantial part of at least one side of said sensor array between the sensor array and the dam wall.

Preferably, said barrier is formed with a height of at least three microns.

Preferably, said barrier surrounds said sensor array.

Preferably, said barrier is formed during fabrication of the sensor chip.

Preferably, where said sensor chip is a colour image sensor including a mosaic of colour filter material overlying said sensor array, said barrier is formed from said colour filter material simultaneously with the formation of said mosaic. Most preferably, said barrier is formed from a plurality of layers corresponding to a plurality of colours of filter material forming said mosaic.

In accordance with a second aspect of the invention, there is provided an image sensor chip, including an image sensor array formed on a top surface thereof, including a barrier formed on the surface of said sensor chip and extending along at least a substantial part of at least one side of said sensor array.

Preferably, said barrier is formed with a height of at least three microns.

Preferably, said barrier surrounds said sensor array.

Preferably, where said sensor chip is a colour image sensor including a mosaic of colour filter material overlying said sensor array, said barrier is formed from said colour filter material simultaneously with the formation of said mosaic. Most preferably, said barrier is formed from a plurality of layers corresponding to a plurality of colours of filter material forming said mosaic.

In accordance with a third aspect of the present invention, there is provided an image sensor device of the type comprising an image sensor chip, including an image sensor array formed on a top surface thereof, mounted on a substrate and encapsulated by means of a dam wall formed on the substrate and surrounding the periphery of the sensor chip and having a transparent lid member affixed to the upper edges of said dam wall, wherein the sensor chip includes a barrier formed on the surface thereof and extending along at least a substantial part of at least one side of said sensor array between the sensor array and the dam wall.

Preferably, said barrier is formed with a height of at least three microns.

Preferably, said barrier surrounds said sensor array.

Preferably, where said sensor chip is a colour image sensor including a mosaic of colour filter material overlying said sensor array, said barrier is formed from said colour filter material simultaneously with the formation of said mosaic. Most preferably, said barrier is formed from a plurality of layers corresponding to a plurality of colours of filter material forming said mosaic.

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Fig. 1 is a plan view of a substrate having a plurality of image sensor chips mounted thereon; and

Fig. 2 is a sectional side view of an embodiment of an image sensor device formed in accordance with the present invention.

Referring now to the drawings, Fig. 1 shows a substrate 10, typically of ceramic material, having an array of individual image sensor chips 12 mounted on an upper surface thereof. Each of the chips 12 includes an image sensor array (not shown) on its top surface.

In accordance with a conventional manufacturing process, after wire bonding, the individual chips 12 are encapsulated in situ on the substrate by writing dam walls (14, Fig. 2) of liquid epoxy material along the gaps between the chips 12 and around the periphery of the array of chips 12. As seen in Fig. 2, the dam walls 14 are formed on the surface of the substrate 10 and overlap the edges of the chips 12. A glass sheet (16, Fig. 2) is then laid on top of the dam walls 14 and bonded to their upper edges, so that each chip 12 is encapsulated between the substrate 12, dam walls 14 and glass sheet 16. The whole assembly is then baked to harden the dam walls 14 and diced by sawing along the dam walls 14 between the chips 12 and around the periphery of the array of chips 12 to produce a plurality of individual, packaged devices.

Fig. 2 shows a cross sectional view of a single image sensor device formed in this manner.

As noted above, a problem which arises with this manufacturing technique is that resin can bleed out of the dam walls 14 while in the liquid state, running by capillary action over the chip surface and thereby onto the image sensing area, causing unacceptable image blemishes. Such resin bleed is indicated at 18 in Fig. 2.

In accordance with the present invention, this problem is obviated or mitigated by forming a barrier 20 on the chip surface between the dam walls 14 and the image sensing array of the chip 12. Such a barrier 20 impedes the progress of the liquid resin and prevents it impinging onto the sensor array 22. It has been found that a barrier at least about 3 microns in height is effective in arresting the resin bleed 18. The barrier 20 may extend around the entire periphery of the sensor array 22. However, depending on the size and location of the sensor array 22 on the chip surface in relation to the dam walls 14, it may be sufficient to form the barrier 20 along at least a substantial part of at least one edge of the sensor array 22.

The barrier 20 may be formed during fabrication of the image sensor chips 12 as an integral part of the manufacturing process, being deposited by means of any conventional chip fabrication process such as photolithography. The barrier 20 may be formed from materials which are conventionally used in the fabrication of the image sensor circuitry on a semiconductor wafer, so that the invention may be implemented at, effectively, zero cost.

In the case of a colour image sensor, it is particularly preferred that the barrier be built from the materials used to form the conventional three-colour filter mosaic on top of the image sensing circuit. The colour filter material is typically of the order of one micron in thickness, so that stacking all three colours of material on top of one another in the barrier area provides the required barrier height of about three microns, without adding to existing manufacturing costs. This barrier construction is illustrated in detail 24 of Fig. 2.

The invention thus provides improved image sensor chips, packaged image sensor devices and methods of manufacturing the same.

Modifications and improvements may be incorporated without departing from the scope of the invention.

Claims

1. A method of manufacturing an image sensor device of the type comprising an image sensor chip, including an image sensor array formed on a top surface thereof, mounted on a substrate and encapsulated by means of a dam wall formed on the substrate and surrounding the periphery of the sensor chip and having a transparent lid member affixed to the upper edges of said dam wall, wherein the method includes forming a barrier on the surface of said sensor chip and extending along at least a substantial part of at least one side of said sensor array between the sensor array and the dam wall.

2. A method as claimed in Claim 1, wherein said barrier is formed with a height of at least three microns.

3. A method as claimed in Claim 1 or Claim 2, wherein said barrier surrounds said sensor array.

4. A method as claimed in any preceding Claim, wherein said barrier is formed during fabrication of the sensor chip.

5. A method as claimed in any preceding Claim, wherein said sensor chip is a colour image sensor including a mosaic of colour filter material overlying said sensor array, and said barrier is formed from said colour filter material simultaneously with the formation of said mosaic.

6. A method as claimed in Claim 5, wherein said barrier is formed from a plurality of layers corresponding to a plurality of colours of filter material forming said mosaic.

7. An image sensor chip, including an image sensor array formed on a top surface thereof, further including a barrier formed on the surface of said sensor chip and extending along at least a substantial part of at least one side of said sensor array.

8. An image sensor chip as claimed in Claim 7, wherein said barrier is formed with a height of at least three microns.

9. An image sensor chip as claimed in Claim 7 or Claim 8, wherein said barrier surrounds said sensor array.

10. An image sensor chip as claimed in any one of Claims 7 to 9, wherein said sensor chip is a colour image sensor including a mosaic of colour filter material overlying said sensor array, and said barrier is formed from said colour filter material simultaneously with the formation of said mosaic.

11. An image sensor chip as claimed in Claim 10, wherein said barrier is formed from a plurality of layers corresponding to a plurality of colours of filter material forming said mosaic.

12. An image sensor device of the type comprising an image sensor chip, including an image sensor array formed on a top surface thereof, mounted on a substrate and encapsulated by means of a dam wall formed on the substrate and surrounding the periphery of the sensor chip and having a transparent lid member affixed to the upper edges of said dam wall, wherein the sensor chip includes a barrier formed on the surface thereof and extending along at least a substantial part of at least one side of said sensor array between the sensor array

and the dam wall.

13. An image sensor device as claimed in Claim 12, wherein said barrier is formed with a height of at least three microns.

14. An image sensor device as claimed in Claim 12 or Claim 13, wherein said barrier surrounds said sensor array.

15. An image sensor device as claimed in any one of Claims 12 to 14, wherein said sensor chip is a colour image sensor including a mosaic of colour filter material overlying said sensor array, and said barrier is formed from said colour filter material simultaneously with the formation of said mosaic.

16. An image sensor device as claimed in Claim 15, wherein said barrier is formed from a plurality of layers corresponding to a plurality of colours of filter material forming said mosaic.

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Claims searched: all

Examiner: Claire Williams
Date of search: 13 January 2000

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:
UK Cl (Ed.R): H1K (KECD, KECX, KPAC, KPAX)
Int Cl (Ed.7): H01L 27/146, 31/02, 31/0203
Other: ONLINE: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A, P	US5923958 (CHOU) Whole document	
A	US5818094 (MATSUO) Whole document	

X	Document indicating lack of novelty or inventive step
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.
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P	Document published on or after the declared priority date but before the filing date of this invention.
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