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(54) **Title**: METHOD OF MANUFACTURING A SPECTRUM ANALYZING SENSOR

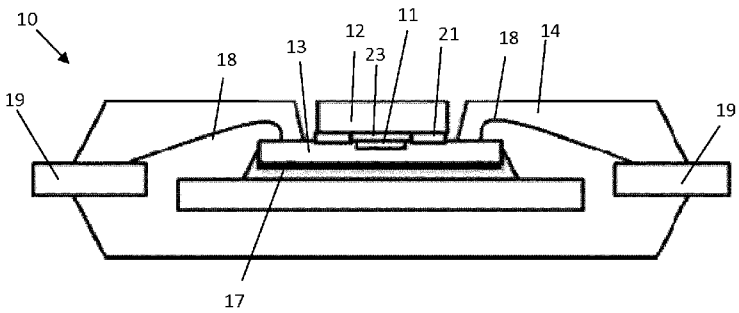


FIG. 3

(57) **Abstract**: The present invention provides a method for manufacturing a spectrum analyzing sensor (10) for example for fuel analysis in automotive applications. The method comprises obtaining a packaged optically active integrated circuit (13) comprising at least one optically active sensor (11) and a moulded package (14) with a package cavity (15) to create an optical window to the at least one optically active sensor (11), and attaching a discrete optical filter (12) for splitting a light spectrum in the package cavity (15).

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Method of manufacturing a spectrum analyzing sensor

Field of the invention

The present invention relates to a manufacturing method of a spectrum analyzing sensor for chemical analysis, in particular for example for fuel analysis in automotive applications. The sensed information is converted into meaningful information in the form of concentrations of specified species.

Background of the invention

In a traditional laboratory, instruments described as spectrometers, spectrophotometers or photometers (referred to from here on as spectrometers) are used to make measurements on liquids or solutions containing one or more chemical substances. A spectrometer is an instrument used to measure properties of light over a specific portion of the electromagnetic spectrum, typically used in spectroscopic analysis to identify materials. The variable measured is typically the light's intensity, but could also, for instance, be the polarization state. The independent variable is usually the wavelength of the light. A spectrometer is used in spectroscopy for producing spectral lines and measuring their wavelengths and intensities.

A typical spectrometer is illustrated in FIG. 1. Light emanating from a light source is modified and split by a grating device or a prism. A CCD camera catches the split light waves. Photons with specific wavelengths will fall on a fixed location of pixels. Software translates the location of the pixels into spectrum data.

US2007/084990 describes a miniaturized, low cost spectral sensing device. The spectral sensing systems described feature specially assembled detection devices that incorporate the spectral selection elements required to generate the spectroscopic data for subsequent analysis. The system comprises an optical spectrometer on a chip as described in US7057156. An optical filter assembly such as a continuous linear variable filter (LVF) has been integrated with a light or energy sensitive array. The LVF is directly bonded to the detector array. The integrated detector array component with filter element is packaged in a clear package, as illustrated in FIG. 2 (reproduction of part of FIG. 2 of US2007/084990).

It is a disadvantage of the spectral sensing device of US2007/084990 that it cannot be used for automotive applications, as the clear package is typically made of clear epoxy, which is not compatible with automotive environment, due to its ageing under influence of the harsh automotive environmental, e.g. leading to discoloration and scratching of the clear packaging material. Packaging the integrated detector array component with filter element in a more reliable dark package, e.g.

black plastic, typically used in automotive applications would destroy its ability to perform its optical function.

Summary of the invention

It is an object of embodiments of the present invention to provide a good method for providing a spectrum analyzing sensor which may be used for chemical analysis, in particular for example for fuel analysis in automotive applications.

The above objective is accomplished by a method according to embodiments of the present invention.

In a first aspect, the present invention provides a method for manufacturing a low-cost, high reliability spectrum analyzing sensor as may be used for performing chemical analysis, for example fuel analysis in automotive applications. A manufacturing method according to embodiments of the present invention comprises obtaining a packaged optically active integrated circuit, optionally provided on a wafer such as a conventional CMOS wafer, the packaged optically active integrated circuit comprising at least one optically active sensor and a moulded plastic package in which electrical connections, e.g. wires, electrically connecting the integrated circuit to peripheral portions are over-moulded and in which a package cavity is provided through which only a sensor optical window is exposed, and gluing an optical filter for splitting a light spectrum in the package cavity. The at least one optically active sensor comprises a plurality of sensor elements. The sensor elements may be placed in one row, or in an array, for example in a multi-row configuration. The optical filter is a discrete optical filter.

The plastic over-moulded package protects the bonding wires, which is extremely important in a harsh environment such as in automotive applications.

The plastic package may be made from conventional black mould compound. The black mould compound prevents stray light to impinge on the sensor. Furthermore, such conventional black mould compound has a lower coefficient of thermal expansion than clear plastic which may also be used for packaging circuitry. Hence the conventional black mould compound has the advantage that, in view of the lower coefficient of thermal expansion, it puts the packaged circuitry under smaller stress in response to temperature variations.

In accordance with embodiments of the present invention, obtaining a packaged optically active integrated circuit may comprise providing an integrated circuit incorporating the at least one optically active sensor wire bonded on a substrate (e.g. a metal leadframe) inserting the integrated circuit into a cavity of a moulding tool (mould chase) ensuring that at least a projection of the moulding tool is in contact with the surface of the optically active sensor, introducing a plastic mould

compound, such as for instance a conventional black mould compound, into the cavity so as to encapsulate, within a package, the wire bonded integrated circuit except for the portion of the optically active sensor in contact with the projection, and removing the packaged integrated circuit from the mould chase whereby the package cavity is defined in the package, through which package cavity light may pass to the optically active sensor.

In particular embodiments, the projection of the mould tool may have a soft surface. This prevents scratches or other damage occurring to the optically active sensor. Additionally, this helps to ensure that the surface of the projection remains in contact with the optically active sensor and ensures that the surface of the optically active sensor stays clear of mould compound.

In embodiments of the present invention, gluing an optical filter in the package cavity may comprise applying adhesive, e.g. glue, onto the optical filter before introducing it into the package cavity for attaching, e.g. gluing, it therein. Applying adhesive onto the optical filter may comprise applying a blob of adhesive onto the optical filter; alternatively, applying adhesive onto the optical filter may comprise applying a patterned adhesive layer onto the optical filter. In this latter case, applying adhesive onto the optical filter may comprise applying the patterned adhesive layer onto the optical filter while being at a filter wafer stage. The method may then further comprise dicing the filter wafer into singulated optical filters before attaching a singulated optical filter in the package cavity.

In an alternative method according to embodiments of the present invention, gluing an optical filter in the package cavity may comprise dispensing adhesive, e.g. glue, into the package cavity and attaching the optical filter in the dispensed adhesive.

A method according to embodiments of the present invention may furthermore comprise potting the optical filter to fill up gaps between the filter and walls of the package cavity. Such potting provides the advantage of contamination resistance. Moreover it enhances reliability of the spectrum analyzing sensor as it aids in keeping the optical filter attached to the at least one optically active sensor, even when used in a harsh environment such as the one of automotive applications, where high temperatures may be applied to spectrum analyzing sensor, and where the different components of the spectrum analyzing sensor may have different expansion coefficients, thus easily generating cracks between the different components.

In a second aspect, the present invention provides a spectrum analyzing sensor for spectral analysis of radiation, for example in an application of chemical analysis, e.g. for fuel analysis in automotive applications. The spectrum analyzing sensor comprises a packaged optically active integrated circuit comprising at least one optically active sensor and a package with a package cavity to create an optical window to the at least one optically active sensor, and an optical filter attached,

e.g. glued, into the package cavity by means of an adhesive, e.g. a glue. The optical filter may be an LVF (linear variable filter), for example a linear variable bandpass filter.

The optical filter may be attached into the package cavity by means of any suitable adhesive, for example by means of an organic glue. In particular embodiments, the optical filter may be attached into the package cavity by means of a bi-stage epoxy. It is particularly advantageous to use a bi-stage epoxy in case the adhesive is applied as a patterned layer onto the optical filter. In this case, the bi-stage epoxy may be partially cured a first time for patterning the adhesive layer, and may be completely cured a second time for attaching the optical filter into the package cavity.

In particular embodiments, the adhesive may be transparent in the application range of optical frequencies. This is particularly relevant in case the adhesive is applied as a blob of adhesive in the package cavity or on the optically active sensor. Alternatively, for example in case the adhesive is only applied at edges of the optical filter, the adhesive may be non-transparent in the application range of optical frequencies.

In embodiments of the present invention, an air cavity may be provided between the optical filter and the at least one optically active sensor.

In embodiments of the present invention, the packaged optically integrated circuit may comprise a dark package. Such dark package is particularly suitable for automotive applications.

A spectrum analyzing sensor according to embodiments of the present invention may furthermore comprise potting material filling up gaps in the package cavity between the optical filter and the package. Such potting material provides the advantage of contamination resistance. Moreover it enhances reliability of the spectrum analyzing sensor as it aids in keeping the optical filter attached to the at least one optically active sensor, even when used in a harsh environment such as the one of automotive applications, where high temperatures may be applied to spectrum analyzing sensor, and where the different components of the spectrum analyzing sensor may have different expansion coefficients, thus easily generating cracks between the different components.

Particular and preferred aspects of the invention are set out in the accompanying independent and dependent claims. Features from the dependent claims may be combined with features of the independent claims and with features of other dependent claims as appropriate and not merely as explicitly set out in the claims.

For purposes of summarizing the invention and the advantages achieved over the prior art, certain objects and advantages of the invention have been described herein above. Of course, it is to be understood that not necessarily all such objects or advantages may be achieved in accordance with any particular embodiment of the invention. Thus, for example, those skilled in the art will recognize that the invention may be embodied or carried out in a manner that achieves or optimizes

one advantage or group of advantages as taught herein without necessarily achieving other objects or advantages as may be taught or suggested herein.

The above and other aspects of the invention will be apparent from and elucidated with reference to the embodiment(s) described hereinafter.

Brief description of the drawings

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

FIG. 1 illustrates the working principle of a typical spectrometer.

FIG. 2 illustrates a prior art integrated sensing system for handheld spectral measurements.

FIG. 3 illustrates a spectrum analyzing sensor for fuel analysis in accordance with a first embodiment of the present invention.

FIG. 4 illustrates a spectrum analyzing sensor for fuel analysis in accordance with a second embodiment of the present invention.

FIG. 5 illustrates a prior art packaged optically active integrated circuit comprising an optically active sensor and a package with a package cavity to create an optical window to the optically active sensor.

FIG. 6 illustrates a filter wafer with patterned adhesive, e.g. glue, which may be used in a production process according to embodiments of the present invention for manufacturing a spectrum analyzing sensor according to embodiments of the present invention.

FIG. 7 illustrates dicing of a filter wafer which may be performed in a manufacturing method in accordance with embodiments of the present invention.

FIG. 8 illustrates a spectrum analyzing sensor for fuel analysis in accordance with a third embodiments of the present invention, where potting material has been applied between the optical filter and walls of the package cavity.

The drawings are only schematic and are non-limiting. In the drawings, the size of some of the elements may be exaggerated and not drawn on scale for illustrative purposes. The dimensions and the relative dimensions do not necessarily correspond to actual reductions to practice of the invention.

Any reference signs in the claims shall not be construed as limiting the scope.

In the different drawings, the same reference signs refer to the same or analogous elements.

Detailed description of illustrative embodiments

The present invention will be described with respect to particular embodiments and with reference to certain drawings but the invention is not limited thereto but only by the claims.

The terms first, second and the like in the description and in the claims, are used for distinguishing between similar elements and not necessarily for describing a sequence, either temporally, spatially, in ranking or in any other manner. It is to be understood that the terms so used are interchangeable under appropriate circumstances and that the embodiments of the invention described herein are capable of operation in other sequences than described or illustrated herein.

Moreover, the terms top, under and the like in the description and the claims are used for descriptive purposes and not necessarily for describing relative positions. It is to be understood that the terms so used are interchangeable under appropriate circumstances and that the embodiments of the invention described herein are capable of operation in other orientations than described or illustrated herein.

It is to be noticed that the term "comprising", used in the claims, should not be interpreted as being restricted to the means listed thereafter; it does not exclude other elements or steps. It is thus to be interpreted as specifying the presence of the stated features, integers, steps or components as referred to, but does not preclude the presence or addition of one or more other features, integers, steps or components, or groups thereof. Thus, the scope of the expression "a device comprising means A and B" should not be limited to devices consisting only of components A and B. It means that with respect to the present invention, the only relevant components of the device are A and B.

Reference throughout this specification to "one embodiment" or "an embodiment" means that a particular feature, structure or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention. Thus, appearances of the phrases "in one embodiment" or "in an embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment, but may. Furthermore, the particular features, structures or characteristics may be combined in any suitable manner, as would be apparent to one of ordinary skill in the art from this disclosure, in one or more embodiments.

Similarly it should be appreciated that in the description of exemplary embodiments of the invention, various features of the invention are sometimes grouped together in a single embodiment, figure, or description thereof for the purpose of streamlining the disclosure and aiding in the understanding of one or more of the various inventive aspects. This method of disclosure, however, is not to be interpreted as reflecting an intention that the claimed invention requires more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive aspects lie in less than all features of a single foregoing disclosed embodiment. Thus, the claims following the

detailed description are hereby expressly incorporated into this detailed description, with each claim standing on its own as a separate embodiment of this invention.

Furthermore, while some embodiments described herein include some but not other features included in other embodiments, combinations of features of different embodiments are meant to be within the scope of the invention, and form different embodiments, as would be understood by those in the art. For example, in the following claims, any of the claimed embodiments can be used in any combination.

It should be noted that the use of particular terminology when describing certain features or aspects of the invention should not be taken to imply that the terminology is being re-defined herein to be restricted to include any specific characteristics of the features or aspects of the invention with which that terminology is associated.

In the description provided herein, numerous specific details are set forth. However, it is understood that embodiments of the invention may be practiced without these specific details. In other instances, well-known methods, structures and techniques have not been shown in detail in order not to obscure an understanding of this description.

As used herein, the term optically active sensor relates to any element operable to sense incident light. An optically active sensor comprises a plurality of optically active sensor elements, which may for example be configured in a line or in an array. Furthermore, the terms optical, optically and light, as used herein, should be understood to refer to electromagnetic radiation in infrared and ultraviolet spectral regions in addition to the visible region of the electromagnetic spectrum.

As used herein, the term adhesive relates to a substance capable of holding materials together by surface attachment. Examples of adhesive are cement, mucilage, paste and glue.

In one aspect, the present invention provides a spectrum analyzing sensor. The spectrum analyzing sensor according to embodiments of the present invention is suitable for chemical analysis, for example fuel analysis, more particularly for fuel analysis in automotive applications, such as for example fuel analysis carried out in a fuel system of a vehicle. A specific application is measurement of the sulfur content in diesel in order to prevent engine damage.

A spectrum analyzing sensor 10 according to embodiments of the present invention comprises an optically active sensor 11, e.g. a semiconductor sensor such as a CMOS sensor with a photodiode array, and a discrete optical filter 12. The optically active sensor 11 forms part of an optically active integrated circuit 13 which is packaged into a package 14 having a package cavity 15 to create an optical window to the optically active sensor 11, for example a small scale JEDEC standard package. An example of such packages 14 having an optical window may be manufactured as described below. The optical filter 12 may be a linear variable filter (LVF), for example a linear

variable bandpass filter. A linear variable filter realizes a single filter that continuously varies wavelengths. It is a filter where the coating has been intentionally wedged in one direction. This wedge causes the center wavelength of the filter to shift linearly across the length of the filter. Adjusting the filter orientation allows a specific wavelength to be selected. Such filters are ideal for applications where high-resolution measurements of a spectrum are needed, for example for fuel analysis.

One embodiment of a spectrum analyzing sensor 10 according to embodiments of the present invention is illustrated in FIG. 3. Another embodiment is illustrated in FIG.4. In both embodiments, the optical filter 12 is attached by means of adhesive, e.g. is glued, into the package cavity 15.

The above embodiments of such spectrum analyzing sensors 10 according to embodiments of the present invention are illustrated and explained in more detail below, with reference to their particular methods of manufacture.

In another aspect, the present invention provides a method for manufacturing a spectrum analyzing sensor 10 according to embodiments of the present invention, wherein the spectrum analyzing sensor 10 comprises an optically active sensor 11, e.g. a semiconductor sensor with a photodiode array, and a discrete variable filter 12.

A method of manufacturing a spectrum analyzing sensor 10 according to embodiments of the present invention comprises obtaining a packaged optically active integrated circuit 13 comprising at least one optically active sensor 11. The optically active integrated circuit 13 is packaged in a plastic package 14 in which electrical connections 18 connecting the integrated circuit 13 to a peripheral portion 19 are over-moulded, and in which a package cavity 15 is provided to create an optical window to the optically active sensor 11. Through the optical window, only a sensor optic window is exposed. Obtaining such a packaged optically active integrated circuit 13 may comprise providing an integrated circuit incorporating the at least one optically active sensor 11 wire bonded on a substrate, inserting the integrated circuit into a cavity of a moulding tool (mould chase) ensuring that at least a projection of the moulding tool is in contact with the surface of the optically active sensor 11, introducing a plastic mould compound into the mould chase so as to encapsulate, within a package, the integrated circuit except for the portion of the optically active sensor 11 in contact with the projection, and removing the packaged integrated circuit from the mould chase whereby the package cavity 15 is defined in the package through which light may pass to the optically active sensor 11.

A method according to embodiments of the present invention may include mounting the optically active sensor 11 on a lead frame 16 by means of epoxy 17, and providing electrical connections 18 between the integrated circuit 13 and peripheral portions 19 of lead frame 16, to

enable the integrated circuit 13 to be connected to external circuitry. The lead frame 16 may be a standard lead frame adapted to mount a variety of different integrated circuits. Alternatively, the lead frame 16 may be especially adapted for the particular integrated circuit 13 to be encapsulated. Electrical connections 18 may be made using conventional wire bonding techniques between the integrated circuit 13 and peripheral portions 19 of the lead frame 16. This provides a mounted and covered assembly. The optically active sensor 11 may comprise light sensing means, for sensing light in a suitable frequency range depending on the application. For protection, the whole device is encapsulated in a package 14, for example a standard black plastic package. Advantage of the black package is that it protects the optically active sensor 11 against stray light. For encapsulating the device in a package 14, the mounted assembly may be placed in a mould tool having a projection with a soft surface opposite to and in contact with the exposed surface of the optically active sensor 11. The soft surface of the projection of the mould tool prevents scratches or other damage occurring to the lid or the optically active sensor 11. Mould compound is then injected into the mould tool to encapsulate the lead frame 16 and the integrated circuit 13 including such parts of the optically active sensor 11 which are not in contact with the soft surface of the mould tool. There where the soft surface of the mould tool is present during injection of the mould compound, the package cavity 15 is formed. This package cavity 15 creates an optical window to the optically active sensor 11. Such packaged optically active integrated circuit is illustrated in FIG. 5.

A method according to embodiments of the present invention furthermore comprises gluing an optical filter 12 into the package cavity 15.

This gluing may be performed in accordance with different embodiments of the present invention.

According to first embodiments, adhesive such as e.g. glue may be applied into the package cavity 15 before introducing the optical filter 12 therein for attaching it, e.g. for gluing it. In particular embodiments of these first embodiments, a blob of adhesive, e.g. glue 20 may be provided into the package cavity 15, after which the optical filter 12 is attached thereto. The resulting spectrum analyzing sensor 10 looks like the embodiment illustrated in FIG. 4.

According to second embodiments, adhesive, e.g. glue, may be applied onto the optical filter 12 before introducing it into the package cavity 15 for attaching, e.g. gluing, it therein.

In particular embodiments, a patterned adhesive layer, e.g. a patterned glue layer 21, may be provided on a filter wafer 22, i.e. on the optical filter before cutting it into parts having the right dimensions. This is illustrated in FIG. 6. Applying a patterned adhesive layer, e.g. a patterned glue layer 21, onto the filter wafer 22 may comprise applying an adhesive layer covering the filter wafer 22 and patterning the applied adhesive layer so as to obtain a patterned adhesive layer, e.g. a patterned

glue layer 21, as desired. An adhesive used in this embodiment may be a bi-stage epoxy. A bi-stage epoxy is one in which a limited reaction between the epoxy and a hardener has taken place so that the product is in a semi-cured state during patterning thereof. A second curing can take place for attaching the optical filter 12 into the package cavity 15. Alternatively a pattern of adhesive material, e.g. glue, may be directly applied onto the filter wafer 22, for example by means of a patterned adhesive transfer roll for transferring adhesive to the filter wafer 22 in an adhesive pattern. The filter wafer 22 may be diced after application of the patterned adhesive layer, e.g. the patterned glue layer 21, as illustrated by the vertical dashed lines in FIG. 7. Dicing the filter wafer 22 provided with a patterned adhesive layer, e.g. glue layer 21, leads to discrete optical filters 12 which can be stick into the package cavity 15 of a packaged optically active integrated circuit comprising an optically active sensor 11.

In accordance with embodiments of the present invention, whether the adhesive is applied into the package cavity 15 or onto the filter wafer 22 or the discrete optical filter 12, the adhesive, e.g. glue, used for attaching, e.g. gluing, the discrete optical filter 12 into the package cavity 15 may for example be a chemical-based adhesive such as epoxy or a silicon based adhesive.

The adhesive may be transparent in the application range of optical frequencies for which the spectrum analyzing sensor 10 is intended to be used. This is particularly relevant in case the adhesive is applied as a blob of adhesive 20 in the package cavity 15 or on the optically active sensor 11. In such cases, for optimal reliability, the adhesive should remain transparent in the application range of optical frequencies for which the spectrum analyzing sensor 10 is intended to be used throughout the lifetime of the spectrum analyzing sensor 10, without severe ageing.

Alternatively, the adhesive may be non-transparent in the application range of optical frequencies for which the spectrum analyzing sensor 10 is intended to be used. In this case, the adhesive may be applied as a pattern, only at the edges of the optical filter 12, such that an optical path to the optically active sensor 11 is kept clear. The adhesive may be applied as a pattern at the edges of the optical filter 12 or in the package cavity 15, such that, when attaching the optical filter 12 into the package cavity 15, the adhesive 21 does not cover the optically active sensor 11. An air cavity 23 may be provided between the optical filter 12 and the optically active sensor 11 in order to keep the optical path clear.

A method according to embodiments of the present invention may further comprise potting the optical filter 12 with potting material 24 to fill up gaps in the package cavity 15 between the optical filter 12 and the package 14. An embodiment of a spectrum analyzing sensor 10 thus obtained is illustrated in FIG. 8. The embodiment illustrated is with a patterned layer of adhesive, e.g. a patterned glue layer 21, for attaching the optical filter 12 into the cavity package 15, but of course

potting may also be applied in case the optical filter 12 is attached into the cavity package 15 by means of a blob of adhesive 20. Potting the optical filter 12 provides a better resistance against dirt. Another advantage of potting the optical filter 12 is a reliability aspect: the potting material 24 may better secure the filter 12 in the package cavity 15. If not potted, the filter 12 could fall apart due to thermal stresses always occurring in automotive environments. Such thermal stresses could create cracks in the adhesive layer applied.

When a spectrum analyzing sensor 10 according to embodiments of the present invention is introduced into a medium to be measured, e.g. into fuel in a fuel system in a vehicle, the fuel comprising a chemical element to be measured, and light is sent through the fuel, through the optical filter 12 for splitting the light spectrum, so as to make light beams split depending on their frequency to fall onto an optically active sensor 11, this sensor 11 will measure the presence of light in different frequency bands. Depending on these measurements, the composition and hence the quality of the fuel can be determined. It is an advantage of spectrum analyzing sensors 10 according to embodiments of the present invention that they are small and hence can be built in into the fuel system of a vehicle. This way, they can be used for determining quality differences of fuel between different refueling operations, thus allowing to adapt the injection of fuel into the motor of the vehicle depending on the exact composition of the fuel. This allows economically and environmentally conscious driving.

While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive. The foregoing description details certain embodiments of the invention. It will be appreciated, however, that no matter how detailed the foregoing appears in text, the invention may be practiced in many ways. The invention is not limited to the disclosed embodiments.

Claims

1.- Method for manufacturing a spectrum analyzing sensor (10), comprising

obtaining a packaged optically active integrated circuit (13) comprising at least one optically active sensor (11) and a package (14) in which electrical connections (18) connecting the integrated circuit (13) to a peripheral portion (19) are over-molded and in which a package cavity (15) is provided through which only a sensor optic window is exposed, and gluing an optical filter (12) for splitting a light spectrum in the package cavity (15).

2.- Method according to claim 1, wherein obtaining a packaged optically active integrated circuit (13) comprises

providing an integrated circuit incorporating the at least one optically active sensor (11),

inserting the integrated circuit into a mould chase of a moulding tool ensuring that at least a projection of the moulding tool is in contact with the surface of the optically active sensor (11),

introducing a mould compound into the mould chase so as to encapsulate, within a package, the integrated circuit except for the portion of the optically active sensor (11) in contact with the projection, removing the integrated circuit from the mould chase, whereby the package cavity (15) is defined in the package through which light may pass to the optically active sensor (11).

3.- Method according to any of the previous claims, wherein gluing an optical filter (12) in the package cavity (15) comprises applying adhesive (20, 21) onto the optical filter (12) before introducing it into the package cavity (15) for attaching it therein.

4.- Method according to claim 3, wherein applying adhesive onto the optical filter (12) comprises applying a blob of adhesive (20) onto the optical filter (12).

5.- Method according to claim 3, wherein applying adhesive onto the optical filter (12) comprises applying a patterned adhesive layer (21) onto the optical filter (12).

6.- Method according to claim 5, wherein applying adhesive onto the optical filter (12) comprises applying the patterned adhesive layer (21) onto the optical filter while being at a filter wafer (22) stage.

7.- Method according to claim 6, furthermore comprising dicing the filter wafer (22) into singulated optical filters (12) before attaching a singulated optical filter (12) in the package cavity (15).

8.- Method according to any of claims 1 or 2, wherein gluing an optical filter (12) in the package cavity (15) comprises dispensing adhesive (20, 21) into the package cavity (15) and attaching the optical filter (12) in the dispensed adhesive (20).

9.- Method according to any of the previous claims, furthermore comprising potting the optical filter (12) to fill up gaps between the filter (12) and walls of the package cavity (15).

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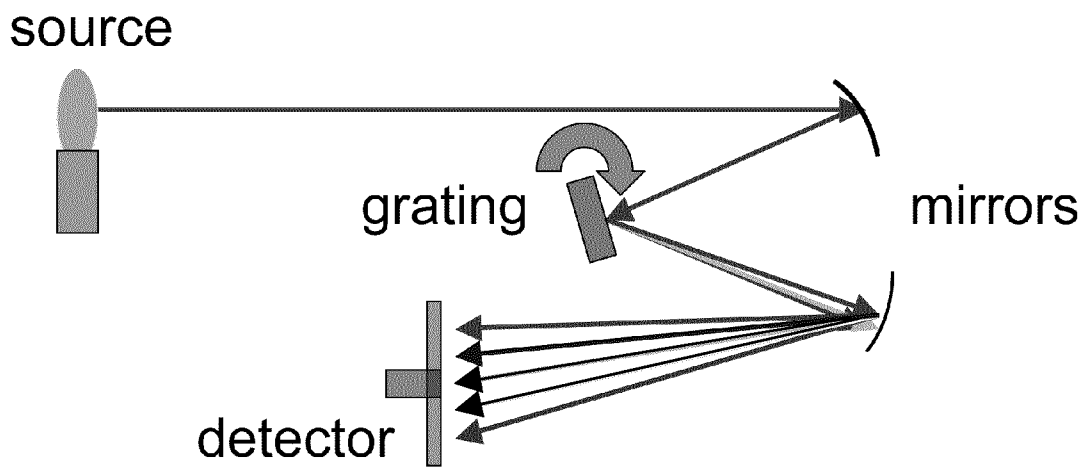


FIG. 1 – PRIOR ART

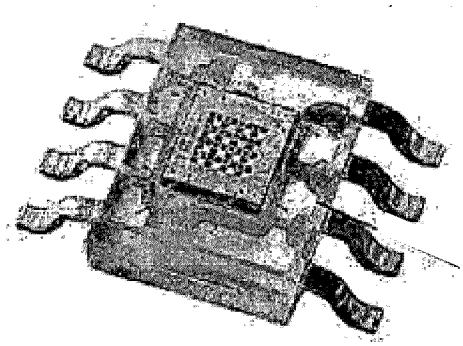


FIG. 2 – PRIOR ART

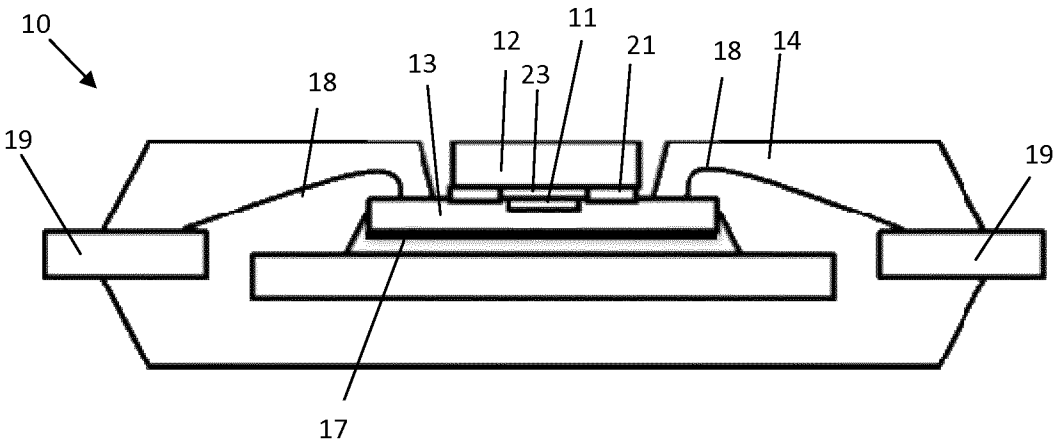


FIG. 3

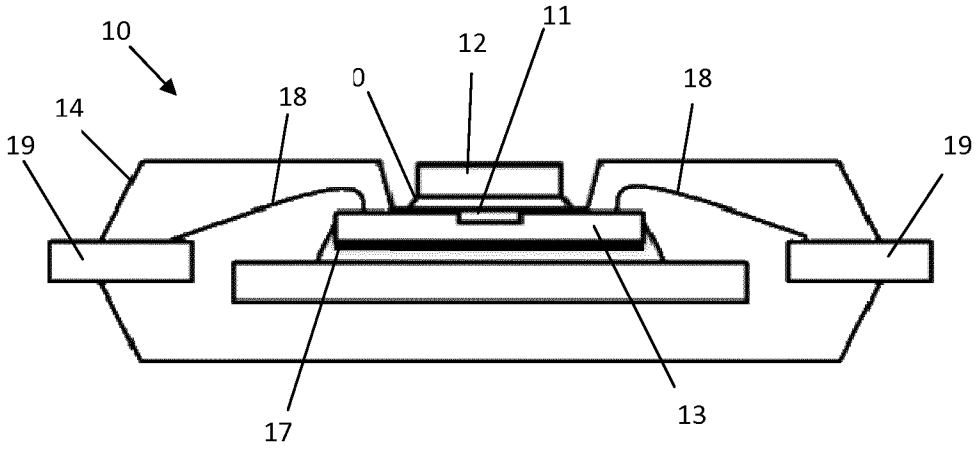


FIG. 4

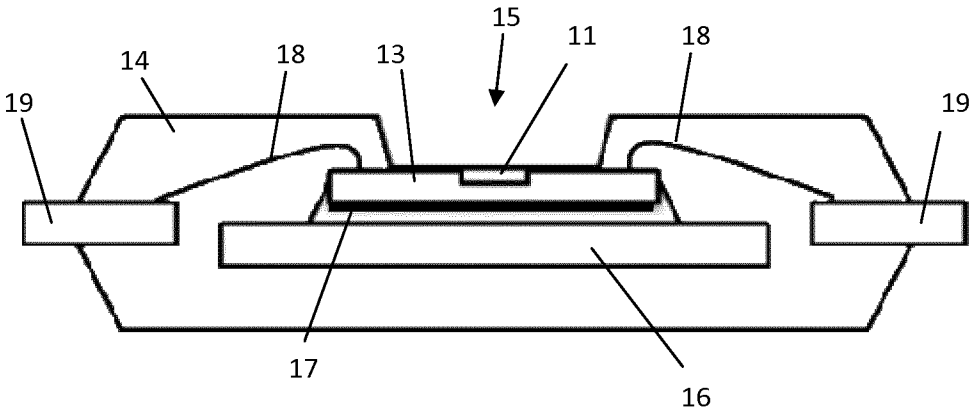


FIG. 5 – PRIOR ART

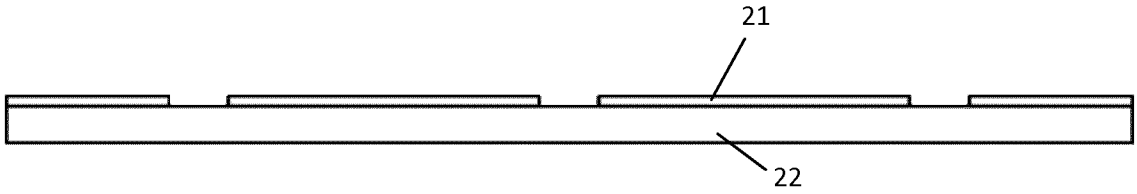


FIG. 6

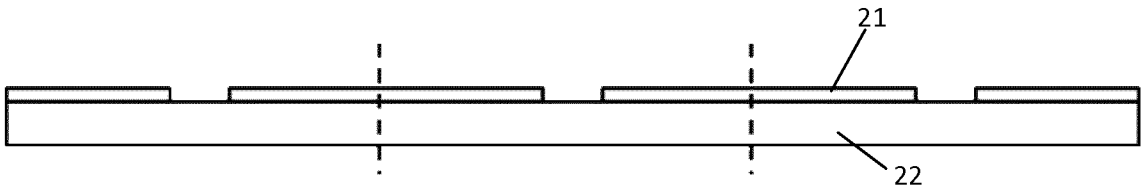


FIG. 7

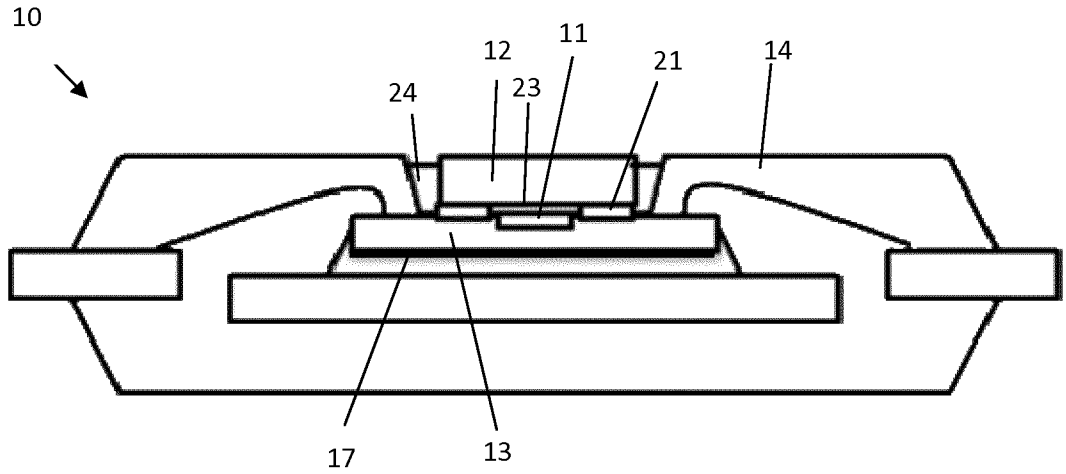


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2012/062158

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/062158

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01L31/0203 H01L31/0232 G01N21/85 G01J3/28 H01L21/00
G01J3/51 G01J3/02
ADD.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01L G01N G01J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 813 236 A1 (EUROP SEMICONDUCTOR ASSEMBLY E [NL] ELMOS ADVANCED PACKAGING B V [NL]) 17 December 1997 (1997-12-17)	1,2
Y	figure 4	1-9

Y	US 2007/084990 A1 (COATES JOHN [US]) 19 April 2007 (2007-04-19) cited in the application figure 2	1-4,8,9

X	US 4 957 371 A (PELLICORI SAMUEL F [US] ET AL) 18 September 1990 (1990-09-18) figure 1	1-4,8,9

Y	KR 2008 0049913 A (TERRASEM CO LTD [KR]) 5 June 2008 (2008-06-05) paragraph [0036]; figure 4	5-7

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 October 2012	06/11/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Rödig, Christoph

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2012/062158

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0813236 A1	17-12-1997	AT 352100 T	15-02-2007
		DE 69737248 T2	24-05-2007
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US 4957371 A	18-09-1990	CA 1332882 C	08-11-1994
		DE 3881385 T2	02-09-1993
		EP 0345327 A1	13-12-1989
		JP H02502490 A	09-08-1990
		US 4957371 A	18-09-1990
		WO 8905465 A1	15-06-1989
KR 20080049913 A	05-06-2008	NONE	

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-4, 8, 9

   details of the sensor structure

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2. claims: 5-7

   preparation of a patterned adhesive layer on filter wafers

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