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(71) Applicant *(for all designated States except US)*: **HEPTAGON MICRO OPTICS PTE. LTD.** [SG/SG]; 87 Defu Lane 10 #04-00, Singapore 539219 (SG).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **RUDMANN, Hartmut** [DE/CH]; Rütiwiesstrasse 20, CH-8645 Jona (CH). **ROSSI, Markus** [CH/CH]; Rütiwiesstrasse 24, CH-8645 Jona (CH).

(74) Agent: **FREI PATENTANWALTSBURÖ AG**; Postfach 1771, CH-8032 Zürich (CH).

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(54) **Title**: OPTO-ELECTRONIC MODULES AND METHODS OF MANUFACTURING THE SAME AND APPLIANCES AND DEVICES COMPRISING THE SAME

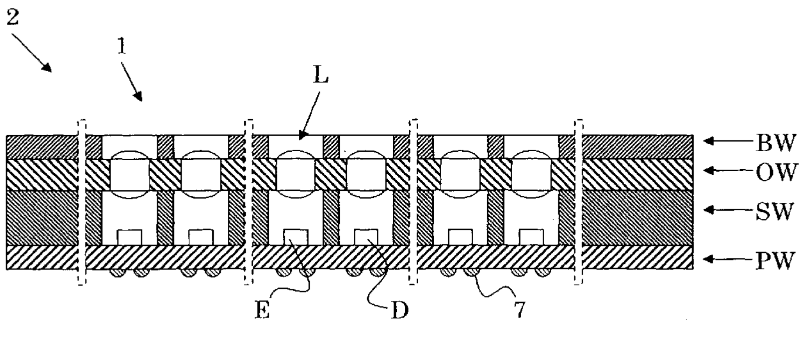

Fig. 4

(57) **Abstract**: The method for manufacturing opto-electronic modules (1) comprises a) providing a substrate wafer (PW) on which a multitude of detecting members (D) are arranged; b) providing a spacer wafer (SW); c) providing an optics wafer (OW), said optics wafer comprising a multitude of transparent portions (t) transparent for light generally detectable by said detecting members and at least one blocking portion (b) for substantially attenuating or blocking incident light generally detectable by said detecting members; d) preparing a wafer stack (2) in which said spacer wafer (SW) is arranged between said substrate wafer (PW) and said optics wafer (OW) such that said detecting members (D) are arranged between said substrate wafer and said optics wafer. Preferably, a multitude of emission members (E) for emitting light generally detectable by said detecting members (D) is arranged on said substrate wafer (PW) such that a multitude of neighboring emission members and detecting members are present on said substrate wafer. Single modules (1) can be obtained by separating said wafer stack (2) into a multitude of separate modules (1).

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OPTO-ELECTRONIC MODULES AND METHODS OF MANUFACTURING THE SAME AND APPLIANCES AND DEVICES COMPRISING THE SAME

Technical Field

The invention relates to the field of opto-electronics and more specifically to the packaging and manufacturing of opto-electronic components. More particularly, it relates to opto-electronic modules and to methods of manufacturing the same and to appliances and to electronic devices comprising such modules, in particular wherein the modules comprise at least one light detector. The invention relates to methods and apparatuses according to the opening clauses of the claims.

Background of the Invention

From US 2010/0327164 A1, an opto-electronic module, more specifically a proximity sensor is known, during the manufacture of which light emitter dice and light detector dice are overmolded using transfer molding techniques so as to form lenses on these dice.

In US 5,912,872, an integrated optical apparatus is presented. In the manufacture thereof, a support wafer having a plurality of active elements thereon is aligned with a transparent wafer having a corresponding plurality of optical elements. Such a support-transparent wafer pair may then be diced apart.

In US 2011/0050979 A1, an optical module for an electro-optical device with a functional element is disclosed. The optical module includes a lens substrate portion with at least one lens element, and a spacer. The spacer serves to keep the lens substrate at a well-defined axial distance from a base substrate portion of the fully assembled electro-optical device. In order to ensure an improved performance of the functional element, an EMC shield is provided. The spacer is at least in parts electrically conductive and thus forms the EMC shield or a part thereof. A method of manufacturing a plurality of such modules on a wafer scale is also disclosed in US 2011/0050979 A1.

Definition of Terms

"Active optical component": A light sensing or a light emitting component. E.g., a photodiode, an image sensor, an LED, an OLED, a laser chip.

"Passive optical component": An optical component redirecting light by refraction and/or diffraction and/or reflection such as a lens, a prism, a mirror, or an optical system, wherein an optical system is a collection of such optical components possibly also comprising mechanical elements such as aperture stops, image screens, holders.

"Opto-electronic module": A component in which at least one active and at least one passive optical component is comprised.

"Replication": A technique by means of which a given structure or a negative thereof is reproduced . E.g., etching, embossing, molding.

"Wafer": A substantially disk- or plate-like shaped item, its extension in one direction (z-direction or vertical direction) is small with respect to its extension in the other two directions (x- and y-directions or lateral directions). Usually, on a (non-blank) wafer, a plurality of like structures or items are arranged or provided therein, typically on a rectangular grid. A wafer may have opening or holes, and a wafer may even be free of material in a predominant portion of its lateral area. Although in many contexts, a wafer is understood to be prevailingly made of a semiconductor material, in the present patent application, this is explicitely not a limitation. Accordingly, a wafer may prevailingly be made of, e.g., a semiconductor material, a polymer material, a composite material comprising metals and polymers or polymers and glass materials. In particular, hardenable materials such as thermally or UV-curable polymers are interesting wafer materials in conjunction with the presented invention.

"Lateral": cf. "Wafer"

"Vertical": cf. "Wafer"

"Light": Most generally electromagnetic radiation; more particularly electromagnetic radiation of the infrared, visible or ultraviolet portion of the electromagnetic spectrum.

Summary of the Invention

One object of the invention is to create an alternative way of manufacturing opto-electronic modules. More particularly, a particularly fast way of manufacturing opto-electronic modules and/or a particularly simple way of manufacturing opto-electronic modules shall be provided. In addition, the respective opto-electronic module, an electronic device comprising such an opto-electronic module and an appliance comprising a multitude of such opto-electronic modules shall be provided.

Another object of the invention is to provide opto-electronic modules having a particularly accurate alignment and a corresponding manufacturing method.

Another object of the invention is to provide opto-electronic modules of particularly small dimensions.

Another object of the invention is to provide opto-electronic modules comprising at least an active and possibly also a passive optical component which are well protected against stray light and/or cross-talk.

Another object of the invention is to provide particularly small electronic devices comprising at least one opto-electronic module.

Further objects emerge from the description and embodiments below.

At least one of these objects is at least partially achieved by apparatuses and methods according to the patent claims.

The method for manufacturing opto-electronic modules comprises the steps of

a) providing a substrate wafer on which a multitude of detecting members are arranged;

b) providing a spacer wafer;

c) providing an optics wafer, said optics wafer comprising a multitude of transparent portions transparent for light generally detectable by said detecting members and at least one blocking portion for substantially attenuating or blocking incident light generally detectable by said detecting members;

d) preparing a wafer stack in which said spacer wafer is arranged between said substrate wafer and said optics wafer such that said detecting members are arranged between said substrate wafer and said optics wafer.

This may allow to manufacture opto-electronic modules in a particularly efficient way, and may allow to manufacture particularly minuscule opto-electronic modules. Furthermore, light incident on such a detecting member may be restricted to desired light, and undesired light, i.e. light which shall not reach the detecting member, may be kept from reaching the detecting member, as it may be absorbed by and/or reflected by said blocking portion. For this purpose, said at least one blocking portion may be at least substantially non-transparent for light detectable by said detecting members.

The feature that said detecting members are arranged "between" said substrate wafer and said optics wafer is to be understood to comprise and to more precisely mean, respectively, the case that the detecting members are comprised in the substrate wafer and that there exists at least another portion of the substrate wafer such that said detecting members are arranged between that other portion of the substrate wafer and said optics wafer.

In case the detection members are comprised in the substrate wafer, one could rather and more clearly say that the wafer stack (cf. step d)) is prepared such that said detection members are arranged "on a side of said substrate facing said optics member", instead of arranged "between said substrate wafer and said optics wafer".

Nevertheless, said detection members may be comprised in said substrate wafer or be not comprised in said substrated wafer.

It is to be noted that the transparency of the transparent portions for light generally detectable by said detecting members does not necessarily mean that the transparent portions have to be transparent for any light generally detectable by said detecting members. Usually, a transparency for a portion of the light generally detectable by said detecting members is sufficient.

Particularly, said substrate wafer is a wafer referred to as substrate wafer, and said spacer wafer is a wafer referred to as spacer wafer, and said optics wafer is a wafer referred to as optics wafer.

Said detecting member is a detector for detecting light, in particular infrared light, more particularly near-infrared light.

Usually, each of said wafers has a generally plate-like shape and comprises a two-dimensional periodic arrangement of structures or items.

In one embodiment, said detecting member is or comprises a photodiode.

In one embodiment which may be combined with the before-addressed embodiment, step d) comprises fixing said substrate wafer to said spacer wafer and fixing said spacer wafer to said optics wafer. Said fixing may in one or both cases be accomplished by gluing.

In one embodiment which may be combined with one or both before-addressed embodiments, step d) comprises aligning said substrate wafer and said optics wafer such that each of said multitude of detecting members is aligned with respect to at least one of said transparent portions, in particular wherein each of said detecting members is aligned in the same way to one of said transparent portions each.

In one embodiment which may be combined with one or more of the before-addressed embodiments, step a) comprises the step of

a1) placing said detecting members on said substrate wafer by pick-and-place.

Carrying out such a pick-and-place operation on wafer-level allows to achieve a high placing accuracy and a high manufacturing speed.

In one embodiment which may be combined with one or more of the before-addressed embodiments, step a) comprises the step of

a2) electrically connecting each of said detection members to said substrate wafer.

This can be accomplished, e.g., by die-bonding or by soldering by reflowing.

In one embodiment which may be combined with one or more of the before-addressed embodiments, each of said multitude of transparent portions comprises at least one passive optical component.

In one embodiment which may be combined with one or more of the before-addressed embodiments, the method comprises providing a wafer which is a combination of said spacer wafer and said optics wafer. Such a wafer can be referred to as "combined optics wafer".

In one embodiment which may be combined with one or more of the before-addressed embodiments, the method comprises the step of manufacturing said blocking portion and said spacer wafer as a unitary part. This may, in particular be accomplished using replication.

Combining wafers (and, correspondingly, the respective members) usually allows to do with a relatively little number of manufacturing steps and in particular with a relatively little number of alignment steps. This may simplify manufacture and/or result in modules of higher precision.

In one embodiment which may be combined with one or more of the before-addressed embodiments, each of said multitude of transparent portions comprises at least one passive optical component such as a lens member (as an example for a passive optical component), in particular wherein each of said passive optical components comprises at least one optical structure, or more particularly, wherein each of said lens members comprises at least one lens element. Such a lens member is or comprises at least one (optical) lens; and such a lens element is a lens which possibly is a portion of a composed lens composed of at least two transparent parts. The lens elements are provided for redirecting light by diffraction or (more typically) by refraction. More generally, said passive optical component are provided for redirecting light by diffraction and/or by refraction and/or by reflection.

In one embodiment referring to the before-addressed embodiment comprising lens elements, said lens elements are or at least each of a portion of said lens elements is of generally convex shape. Of course, also partially or generally concave shapes or other shapes, e.g., combining concave and convex regions, are possible.

In one embodiment referring to one or more of the before-addressed embodiments comprising passive optical components, each of said passive optical components or each of a portion of said passive optical components is associated with at least one of said detecting members each.

In one embodiment referring to one or more of the before-addressed embodiments comprising lens members, each of said lens members or each of a portion of said lens members is associated with at least one of said detecting members each.

In one embodiment referring to one or more of the before-addressed embodiments comprising passive optical components (such as lens members), the method comprises the step of

c1) manufacturing said passive optical components by means of replication.

Replication can be a very efficient way of producing a multitude of, e.g., lenses and lens elements, respectively. It may be possible to save many alignment steps and/or a lot of manufacturing time this way.

In one embodiment referring to the before-addressed embodiment, step c1) comprises replicating a surface in a liquid, viscous or plastically deformable material and subsequently hardening, in particular curing, said material. Suitable materials can be, e.g., polymers such as epoxy resins.

In one embodiment referring to the before-addressed embodiment, said replicating of said surface comprises embossing said surface into said material.

In one embodiment referring to one or both of the two last-addressed embodiments, said hardening said material is accomplished by at least one of heating and irradiating with light, in particular with ultraviolet light. In particular, said hardening can be curing.

In one embodiment which may be combined with one or more of the before-addressed embodiments, said spacer wafer is made of a material which substantially attenuates or blocks light generally detectable by said detecting members. Using for said spacer wafer a material which is substantially non-transparent for light detectable by said detecting members can make it possible to shield the detecting members from undesired light such as stray light from outside the module or, if emission members are provided (see below), to prevent cross-talk from the emission members to the detecting members.

In one embodiment referring to the before-addressed embodiment, a multitude of emission members for emitting light generally detectable by said detecting members is arranged on said substrate wafer, in particular wherein the emission members are arranged such that a multitude of neighboring emission members and detecting members are present on said substrate wafer. Typically, each of said emission members is associated with one of said detecting members.

With respect to the emission members and their emitted light spectrum, it is to be noted that the emission of light generally detectable by said detecting members does neither mean that the emitted light necessarily has to cover the full wavelength range of light generally detectable by said detecting members, nor that an (additional) emission of light not generally detectable by said detecting members would be excluded. Usually, a transparency for a portion of the light generally detectable by said detecting members is sufficient. Usually, an emission of light a portion of which falls into the wavelength range generally detectable by said detecting members is sufficient.

In one embodiment referring to one or both of the two last-addressed embodiments, said emission members are placed on said substrate wafer for emitting said light in a direction generally perpendicular to the extension of said substrate. This way, vertically propagating light is emitted which usually will run through one of said transparent portions.

In one embodiment referring to one or more of the embodiments comprising said emission members, each of said passive optical components or each of a portion of said passive optical components is associated with one of said emission members each.

In one embodiment referring to one or more of the embodiments comprising said emission members and lens members, each of said lens members or each of a portion of said lens members is associated with one of said emission members each.

In one embodiment referring to one or more of the embodiments comprising said emission members, said multitude of passive optical components comprises one plurality of passive optical components associated with one of said emission members each and another plurality of passive optical components associated with one of said detecting members each. This way, modules comprising an emission member arranged below an associated passive optical component (e.g., lens member) and a detecting member arranged below an associated passive optical component (e.g., lens member; these lens members being not identical with the before-mentioned ones) can well be manufactured. Therein, “below” refers to a generally vertical direction (with respect to the wafer extension).

In one embodiment referring to one or more of the embodiments comprising said emission members, said spacer wafer is structured and arranged such that it reduces optical cross-talk between said emission members and said detecting members. This can allow to reduce optical cross-talk in the sense of reducing or nullifying the amount of light emitted by said emission member and detected by said detecting member which has reached said detecting member via an undesired optical path, e.g., having been scattered (in an undesired way) within the opto-electronic module or having reached said detecting member without having left said opto-electronic module. It can allow to substantially attenuate or block light emitted by said emission member which did not pass (two times) through said optics wafer.

In one embodiment which may be combined with one or more of the before-addressed embodiments, the method comprises the step of

h) obtaining said spacer wafer by means of a replication process.

This can make the manufacture of the modules particularly efficient. For example, said replication process can comprises an embossing step. As a material for said spacer wafer, a polymer-based material such as an epoxy resin, in particular a curable material, can be a suitable choice.

In one embodiment which may be combined with one or more of the before-addressed embodiments, the material of which the optics wafer is substantially made in the blocking portion is a hardened hardenable material (in particular a cured curable material), e.g., a polymer-based material such as an epoxy resin.

In one embodiment which may be combined with one or more of the before-addressed embodiments, the portion of the optics wafer in the blocking portion is obtained using a replication process.

In one embodiment which may be combined with one or more of the before-addressed embodiments, said opto-electronic modules are proximity sensors.

In one embodiment which may be combined with one or more of the before-addressed embodiments, the method comprises the step of

e) providing said substrate wafer with solder balls on that side of the substrate sensor which is opposed to that side of the substrate member on which said detecting members are arranged.

It is also possible to provide a substrate wafer having contact pads not provided with solder balls.

This way, the manufactured modules can be readily used in the manufacture of electronic devices, e.g., it can be used as a surface mount device.

In one embodiment which may be combined with one or more of the before-addressed embodiments, the method comprises the step of

f) separating said wafer stack into a multitude of separate modules each comprising

— a portion of said substrate wafer;

— at least one of said detecting members;

— a portion of said spacer wafer;

— at least one of said transparent portions;

— a portion of said blocking portion.

This way, separate opto-electronic modules are obtained in a very efficient way. The separating (or dicing) can be accomplished by, e.g., by means of a mechanical tool such as a wafer saw or a punch cutter, or by means of a laser.

In one embodiment which may be combined with one or more of the before-addressed embodiments, the method comprises the step of

g) providing a baffle wafer arranged next to said optics wafer on that side of said optics wafer which is opposed to that side of said optics wafer on which said spacer wafer is arranged, said baffle wafer comprising a multitude of transparent regions;

wherein step d) is replaced by the step of

d') preparing a wafer stack in which said spacer wafer is arranged between said substrate wafer and said optics wafer such that said detecting members are arranged between said substrate wafer and said optics wafer, and wherein said optics wafer is arranged between said baffle wafer and said spacer wafer.

By means of the baffle wafer, it is possible to limit an angular range within which light incident on said baffle layer can enter the modules and/or reach at least a portion of said multitude of detection members.

More particularly, said baffle wafer is a wafer referred to as baffle wafer.

Typically, each of said transparent regions or each of a portion of said transparent regions is associated with at least one of said detecting members; and/or, if said emission members are provided, each of said transparent regions or each of a portion of said transparent regions is associated with at least one of said emission members.

Said transparent regions can, e.g., be formed by holes through said baffle wafer and/or by material transparent for light generally detectable by said detecting members.

In one embodiment referring to the last-addressed embodiment, said baffle wafer is partially or even substantially made of a resilient or of an elastically or plastically deformable material. E.g., a foam or a foam-like material can be used.

In one embodiment which may be combined with one or both last-addressed embodiments, the material of which the baffle wafer is substantially made is a hardened hardenable material (in particular a cured curable material), e.g., a polymer-based material such as an epoxy resin. Note that it is possible to provide that in the hardened or cured state, the material is resilient.

In one embodiment which may be combined with one or more of the three last-addressed embodiments, the baffle wafer is obtained using a replication process.

In one embodiment which may be combined with one or more of the four last-addressed embodiments, the method comprises providing a wafer which is a combination of said baffle wafer and said optics wafer. Such a wafer can be referred to as "combined optics wafer".

In one embodiment which may be combined with one or more of the five last-addressed embodiments, the method comprises the step of manufacturing said blocking portion and said baffle wafer as a unitary part. This may, in particular be accomplished using replication.

Combining wafers (and, correspondingly, the respective members) usually allows to do with a relatively little number of manufacturing steps and in particular with a relatively little number of alignment steps. This may simplify manufacture and/or result in modules of higher precision.

In one embodiment which may be combined with one or more of the before-addressed embodiments, the said substrate wafer substantially is a printed circuit board assembly, more particularly a printed circuit board on which at least one active optical component is mounted. This way, the well-known techniques of printed circuit board fabrication can be used for the manufacture of said substrate wafer. A printed circuit board arrangement (PCBA) comprises a printed circuit board (PCB). It can be merely a printed circuit board or (more typically) be a printed circuit board with one or more electrical or electronic components mounted thereon, wherein said one or more components may in particular be active optical components such as said detecting members and/or said emission members.

Contact areas for electrically contacting said detecting members and, if provided, said emission members, and contact areas electrically contacting said modules from the outside and electrical connections (vertically) across said substrate wafer can thus be readily provided.

In fact, this leads to another (second) aspect of the invention which will be discussed below.

The opto-electronic module comprises

— a substrate;

— an optics member arranged generally parallel to said substrate;

— a detecting member arranged between said substrate and said optics member, mounted on said substrate, for detecting light having passed through said optics member;

— a separation member arranged between said substrate and said optics member;

wherein said optics member comprises at least one transparent portion transparent for light generally detectable by said detecting member and at least one blocking portion for substantially attenuating or blocking incident light generally detectable by said detecting member.

Such a module can provide a particularly good manufacturability and a particularly accurate and/or simple alignment of constituents, and it can be designed to be very small.

Said detection member may, generally, be comprised in said substrate or be not comprised in said substrate. In case the detection member is comprised in the substrate, one could rather and more clearly say that the detection member is arranged "on a side of said substrate facing said optics member", instead of arranged "between said substrate and said optics member".

The invention comprises opto-electronic modules with features of corresponding methods according to the invention, and vice versa also methods with features of corresponding opto-electronic modules. Some specific embodiments of the modules are explicitely described below.

The advantages of the modules basically correspond to the advantages of corresponding methods and vice versa.

In one embodiment of the module, said separation member is arranged beside said detecting member.

In one embodiment of the module which may be combined with the before-addressed embodiment, said at least one blocking portion is made of a material which substantially attenuates or blocks light generally detectable by said detecting member. In particular, said material is a thermally cured material.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, said substrate is a generally planar substrate.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, said substrate is a generally plate-like substrate.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, said optics member is a generally planar optics member, at least when disregarding possibly existing protruding lens member portions or protruding portions of other passive optical components.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, said optics member is a generally plate-like optics member.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, said separation member is a generally planar separation member.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, said separation member is a generally plate-like separation member.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, said separation member has one or more openings. Typically, said detecting member is arranged in one of these openings.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, said optics member and said separation member are combined in one member. In particular, said at least one blocking portion and said separation member are manufactured as a unitary part, e.g., using replication.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, said detecting member is a packaged electrical component, e.g., an SMT device.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, except for the last-addressed embodiment, said detecting member is an unpackaged electrical component, e.g., a flip chip or a chip attached to said substrate by wire-bonding.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, said transparent portion comprising at least one passive optical component, or, more particularly, at least one lens member.

In one embodiment referring to the before-addressed embodiment, said at least one passive optical component (or said at least one lens member) comprises at least one optical structure (or at least one lens element), wherein said at least one optical structur (or said at least one lens element) is at least one of made of a hardened hardenable material and obtained using a replication process. In particular, said hardened hardenable material is hardened by at least one of heating and irradiating with light, in particular ultraviolet light. More particularly, said hardening is a curing. Said replication process may comprise an embossing step.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, said substrate and said optics member are fixed to each other via said separation member.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, said separation member extends substantially from said substrate to said optics member.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, said separation member is glued to said optics member and to said substrate, e.g., by means of a thermally curing glue, e.g., a suitable epoxy resin.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, said substrate, said optics member and said separating member are of generally block- or plate-like shape, at least said separating member having at least one hole, in particular wherein said hole extends through said separating member. This way, it is possible that a particularly good manufacturability is achieved.

In one embodiment of the module referring to the before-addressed embodiment, said detecting member is arranged within said hole.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, wherein said substrate, said optics member and said separating member have rectangularly arranged outer surfaces.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, lateral dimensions of

— said substrate;

— said optics member;

— said separation member;

are substantially identical, in particular wherein the lateral dimensions of said module are substantially identical therewith.

The term lateral dimensions refers to dimensions measured substantially perpendicular to the direction in which said substrate and said separation member and said optics member are subsequently arranged. With the lateral outer dimensions of substrate, optics member and separation member being substantially identical, the manufacturability of the module is greatly enhanced.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, the module comprises an emission member for emitting light generally detectable by said detecting member.

In one embodiment referring to the before-addressed embodiment, at least a portion of said separation member is arranged between said emission member and said detecting member for reducing optical cross-talk between said emission member and said detecting member.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, said detecting member is encircled by said separating member.

In one embodiment referring to one or more of the before-addressed module embodiments comprising an emission member, said emission member is encircled by said separating member.

In particular, it can be provided that a portion of side walls (circumferential side walls) of said module are formed by said separation member.

In one embodiment referring to one or more of the before-addressed embodiments comprising an emission member, said optics member comprises at least a first and a second lens members comprising at least one lens element each. In particular, it can be provided that said first and second lens members form a first and a second transparent portion, respectively, of said optics member, and more particularly, wherein said first and second lens members are surrounded by said blocking portion.

In one embodiment referring to the last-addressed embodiment, viewed in a direction generally perpendicular to said substrate (vertical direction), said emission member and said first lens member are arranged one after the other, and said detecting member and said second lens member are arranged one after the other. Such a module can be very small and highly functional.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, said emission member is a packaged electrical component, e.g., an SMT device.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments comprising an emission member, except for the last-addressed embodiment, said emission member is an unpackaged electrical component, e.g., a flip chip or a chip attached to said substrate by wire-bonding.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments comprising an emission member, said emission member, said optics member and said detecting member are structured and arranged such, that when light emitted from said emission member having passed said at least one transparent portion and having been reflected by a surface located outside the module and having passed said at least one transparent portion again is detected by said detecting member, an amount of the so-detected light depends on a distance of said surface to said optics member.

Therein, said surface located outside the module usually will be located near said optics member, e.g., in typical applications, in a distance below 1 m, more particularly below 20 cm or even below 8 cm.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, said separation member is made of a material which substantially attenuates or blocks light generally detectable by said detecting member. This can be particularly helpful when the separation member is provided for substantially attenuating or blocking light generally detectable by said detecting member, but incident from a side of the separation member opposed to a side of the separation member facing said detecting member, from being detected by said detecting member.

Usually, said separation member is not a portion of said substrate and not a portion of said optics member. Typically, said separation member is a unitary part

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, said separation member is at least one of made of a hardened hardenable material and obtained using a replication process. More particularly, said hardening is a curing. In particular, said hardened hardenable material (or cured curable) can be hardened (cured) by application of heat.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, said at least one transparent portion is substantially made of a polymer-based material, e.g., of an epoxy resin, or in particular of a cured curable material.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, said at least one blocking portion is substantially made of a polymer-based material, e.g., of an epoxy resin.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, said substrate provides at least one electrical connection from said detection member across said substrate. This is an elegant way to electrically contact (from the outside) active optical components located within the module.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, said substrate is a printed circuit board assembly. Since this printed circuit board assembly is a constituent of a package, namely of said module, it can also be referred to as an interposer with at least one active optical component mounted thereon. The printed circuit board (PCB) material may, e.g., be a rigid or a flexible PCB material, a fiber-reinforced or not fiber-reinforced material, it may be epoxy-based such as FR4 or polyimide. Active optical components may be mounted on the PCB, e.g., by means of wire bonding or soldering. The same applies also to the PCB of the PCB assembly possibly constituting the substrate wafer.

Usually, at least one of said detecting member and said emission member is electrically connected to said substrate member, typically both, wherein this can be accomplished, e.g., by soldering, by surface mount technology (SMT) or by flip-chip technology or by wire-bonding.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, the module comprises a baffle member arranged next to said optics member on that side of said optics member which is opposed to that side of said optics member on which said separation member is arranged. The baffle member can be structured and arranged for protection from undesired light, in particular for protection of the detecting member from undesired light, and/or for functioning as an aperture.

In one embodiment of the module referring to the last-addressed module embodiment, the baffle member is partially or even substantially made of a resilient or of an elastically or plastically deformable material. This can be helpful, e.g., when mounting the module. For example, when a module is arranged within a housing in mechanical contact to a window of the housing, mounting tolerances can be absorbed by a resilient baffle member, e.g., making the distance of a printed circuit board on which the module is mounted to said window less critical, the resilient baffle member accounting for variations in that distance by readily deforming and adjusting itself.

In one embodiment of the module to be combined with one or both of the last-addressed module embodiments, the baffle member and the optics member are combined in one member; in particular, the at least one blocking portion and the spacer member are manufactured as a unitary part, e.g., using replication.

In one embodiment of the module which may be combined with one or more of the before-addressed module embodiments, wherein the module is a proximity sensor.

The appliance comprises a multitude of modules according to the invention. And the appliance comprises a substrate wafer, an optics wafer, a spacer wafer, wherein the multitude of substrates is comprised in said substrate wafer, the multitude of optics members is comprised in said optics wafer, the multitude of separation members is comprised in said spacer wafer. Usually, said appliance can be considered a wafer stack. And usually, all said wafers are generally planar and generally disk- or plate-shaped, in case of the optics wafer at least when disregarding possibly existing protruding lens member portions (or more generally protruding portions of passive optical components).

The electronic device comprises a printed circuit board and a module according to the invention mounted on said printed circuit board. For example, the device is a hand-held communication device. The device could also be a photographic device, such as a photo camera.

It is another aspect (second aspect) of the invention to provide a method for manufacturing opto-electronic modules which comprises the steps of

a') providing a substrate wafer on which a multitude of detecting members are arranged;

b') providing a spacer wafer;

c') providing an optics wafer;

d') preparing a wafer stack in which said spacer wafer is arranged between said substrate wafer and said optics wafer such that said detecting members are arranged between said substrate wafer and said optics wafer,

wherein said substrate wafer substantially is a printed circuit board assembly.

Particular embodiments of this method according to said second aspect are readily conceivable when combining this method with the methods described above, including or excluding the feature that said optics wafer comprises a multitude of transparent portions and at least one blocking portion.

Similarly, in this second aspect of the invention, the following opto-electronic modules, appliances and electronic devices are comprised:

An opto-electronic module comprising

— a substrate substantially being a printed circuit board assembly;

— an optics member arranged generally parallel to said substrate;

— a detecting member arranged between said substrate and said optics member, mounted on said substrate, for detecting light having passed through said optics member;

— a separation member arranged between said substrate and said optics member.

An appliance comprising a multitude of modules according to the second aspect of the invention.

An electronic device comprising a printed circuit board and a module according to the second aspect of the invention mounted on said printed circuit board.

Particular embodiments of these opto-electronic modules and appliances and electronic devices, respectively, according to said second aspect are readily conceivable when combining these with the opto-electronic modules and appliances and electronic devices, respectively, described above, including or excluding the feature that said optics member comprises at least one transparent portion and at least one blocking portion.

MORE GENERAL VIEW:

It is to be noted that it is possible that a wafer ("combined optics wafer") is provided which is a combination of the described optics wafer and the described spacer wafer. Accordingly, then, the spacer wafer is optional, its properties and functions are fulfilled by an optics wafer which is structured and configured accordingly. This can be accomplished, e.g., by manufacturing as a unitary part: what is described above as spacer wafer and what is described above as at least one blocking portion. Analogously, a "combined optics wafer" can be provided which can be understood as a combination of the described optics wafer and the described baffle wafer. And, it is also possible to provide that the "combined optics wafer" can be understood as a combination of the described optics wafer and the described spacer wafer and the described baffle wafer.

Correspondingly, it is possible that a member is provided which is a combination of the described optics member and the described separation member. Accordingly, then, the separation member is optional, its properties and functions are fulfilled by an optics member which is structured and configured accordingly. This can be accomplished, e.g., by manufacturing as a unitary part: what is described above as separation member and what is described above as at least one blocking portion. An alternative or additional combination with the baffle member is, of course, also possible.

In other words, it applies to any of the disclosed embodiments that the spacer wafer and/or the baffle wafer (if at all present) may be comprised in the optics wafer or may be separated therefrom; and that the separation member and/or the baffle member (if at all present) may be comprised in the optics member or may be separated therefrom.

The more general method accordingly reads as follows:

A method for manufacturing opto-electronic modules, said method comprising the steps of

A) providing a substrate wafer on which a multitude of detecting members are arranged;

C) providing an optics wafer, said optics wafer comprising a multitude of transparent portions transparent for light generally detectable by said detecting members and at least one blocking portion for substantially attenuating or blocking incident light generally detectable by said detecting members;

D) preparing a wafer stack comprising said substrate wafer and said optics wafer.

The more general opto-electronic module accordingly reads as follows:

An opto-electronic module comprising

— a substrate;

— an optics member arranged generally parallel to said substrate;

— a detecting member arranged between said substrate and said optics member, mounted on said substrate, for detecting light having passed through said optics member;

wherein said optics member comprises at least one transparent portion transparent for light generally detectable by said detecting member and at least one blocking portion for substantially attenuating or blocking incident light generally detectable by said detecting member.

The various more refined embodiments of the method and the opto-electronic module are readily derived from the embodiments described above, as are the appliance and the electronic device. The features and suggestions described above are readily transferred onto the claims representing the depicted more general view.

Further embodiments and advantages of the invention (in its first and second aspects and in the more general view) emerge from the dependent claims and the figures.

Brief Description of the Drawings

Below, the invention is described in more detail by means of examples and the included drawings. The figures show schematically:

Fig. 1 a cross-sectional view of an opto-electronic module;

Fig. 2 various cross-sectional views of constituents of the module of Fig. 1;

Fig. 3 a cross-sectional view of wafers for forming a wafer stack for manufacturing a multitude of modules of Fig. 1;

Fig. 4 a cross-sectional view of a wafer stack for manufacturing a multitude of modules of Fig. 1;

Fig. 5 a cross-sectional view of a semi-finished part having a structured surface;

Fig. 6 a cross-sectional view of an opto-electronic module comprising a combined optics member comprising a separation member and a baffle member.

The reference symbols used in the figures and their meaning are summarized in the list of reference symbols. The described embodiments are meant as examples and shall not confine the invention.

Detailed Description of the Invention

Fig. 1 shows a schematic cross-sectional view of an opto-electronic module 1. The illustrated cross-section is a vertical cross-section. Fig. 2 shows various lateral schematic cross-sectional views of constituents of the module of Fig. 1, wherein the approximate positions of these lateral cross-sections are indicated in Fig. 1 by s1 to s5 and dashed lines. For s4 and s5, the direction of view is indicated by arrows.

Module 1 comprises several constituents (P, S, O, B) stacked upon each other in a direction through which the term "vertical" is defined; it corresponds to the z direction (cf. Fig. 1). Directions in the x-y plane (cf. Fig. 2) perpendicular to the vertical (z) direction are referred to as "lateral".

Module 1 comprises a substrate P, a separation member S, an optics member O and a baffle member B stacked upon each other. Substrate P is, e.g., a printed circuit board assembly. The printed circuit board (PCB) of this PCB assembly can more specifically also be referred to as an interposer. On the PCB, an emission member E for emitting light, in particular infrared light (more particularly near-infrared light), can be mounted, e.g., a light-emitting diode; and a detecting member D can be mounted thereon, for detecting light, in particular infrared light (more particularly near-infrared light, e.g., a photo diode. Electrical contacts of emission member E and detecting member D are electrically connected to the outside of module 1, where solder balls 7 are attached. Instead of providing solder balls 7, it would also be possible to provide contact pads on the PCB which are not (or at a later time) provided with solder balls.

This way, module 1 can be mounted on a printed circuit board 9, e.g., in surface mount technology (SMT), next to other electronic components (not shown). Printed circuit board 9 may be a constituent of an electronic device 10 such as a hand-held communication device. In particular, device 10 can be a smart phone. Module 1 is particularly suitable for such an application because it can be manufactured having a particularly small size.

Separation member S has two openings 4, emission member E arranged in one of them and detecting member D being arranged in the other. This way, emission member E and detecting member D are laterally encircled by separating member S.

Separation member S may fulfill several tasks. It can ensure a well-defined distance between substrate P and optics member O (through its vertical extension) which helps to achieve well-defined light paths from emitting member E through optics member O and from the outside of module 1 through optics member O onto detecting member D. Separation member S can also provide protection of detecting member D from light that is not supposed to be detected by detection member D, by being substantially non-transparent to light generally detectable by detecting member D and by forming a portion of the outside walls of module 1. And, separation member S can also provide protection of detecting member D from light emitted by emitting member E which should not reach detecting member D, so as to reduce optical cross-talk between emission member E and detecting member E, by being substantially non-transparent to light generally detectable by detecting member D and by forming a wall between emission member E and detecting member D. Light reflected inside module 1 and stray light originating from emission member E can be kept from reaching detecting member D this way. Typically, separating member S is made of a polymer material, in particular of a hardenable or more specifically curable polymer material, e.g., of an epoxy resin.

Optics member O comprises a blocking portion b and two transparent portions t, one for allowing light emitted by emission member E to leave module 1, and another one for allowing light to enter module 1 from the outside of module 1 and reach detecting member D.

Blocking portion b is substantially non-transparent for light generally detectable by detecting member D, e.g., by being made of a suitable (polymer) material. Transparent portions t comprise a passive optical component L or, more particularly and as an example, a lens member L each, for light guidance. Lens members L may, e.g., comprise, as shown in Fig. 1, two lens elements 5 in close contact to a transparent element 6. Transparent elements 6 can have the same vertical dimension as optics member O where it forms blocking portion b, such that optics member O where it forms blocking portion b together with transparent elements 6 describes a (close-to-perfect) solid plate shape. Lens elements 5 redirect light by refraction (cf. Fig. 1) and/or by diffraction. E.g., they may all be of generally convex shape (as shown in Fig. 1), but one or more of lens elements 5 may be differently shaped, e.g., generally or partially concave.

Baffle member B allows to shield undesired light, in particular light leaving module 1 or incident to module 1 in an desired angle. Usually, baffle member B will have two separate transparent regions 3 which may be embodied as openings or by means of transparent material. Baffle member B can, outside the transparent regions 3, be made of a material substantially attenuating or blocking light generally detectable by said detecting members, or it could be provided with a coating having such a property, wherein the latter will usually be more complex to manufacture. The shape of baffle member B or more precisely of the transparent regions 3, can, of course, be different from what is shown in Figs. 1 and 2, e.g., describe cone-like shapes or describe a truncated pyramid.

The lateral shape not only of the transparent regions 3, but also of the transparent portions t and of the openings 4 do not have to be circular, but may have other appearances, e.g., polygonal or rectangular with rounded corners.

Module 1 is an opto-electronic component, more precisely a packaged opto-electronic component. The vertical side walls of module 1 are formed by items P, S, O and B. A bottom wall is formed by substrate P, and a top wall by baffle member B or by baffle member B together with optics member O.

As is well visible in Fig. 2, the four items P, S, O, B, which can for the reasons above also be referred to as housing components, all have substantially the same lateral shape and lateral dimensions. This is related to a possible and very efficient way of manufacturing such modules 1 which is described in more detail below referring to Figs. 3 and 4. These housing components P, S, O, and B are all of generally block- or plate-like shape or more generally of generally rectangular parallelepiped shape, possibly having holes or openings (such as baffle member B and separation member S do) or projections (such as optics member O does).

The module 1 shown in Fig. 1 can be a proximity sensor. Such a module 1 would allow to detect whether or not an object is located within a predefined distance to the module, e.g., as judged from a photocurrent outputted by detecting member D, while emission member E would be emitting light, possibly in form of light pulses. For example, emission member E, optics member O and detecting member D could be arranged such, that a surface capable of reflecting light located within a predefined distance or distance range of optics member O could enable a detection by detecting member D of a sufficiently high intensity of light emitted by emission member E and reflected by said surface, whereas light emitted by emission member E and reflected by such a surface located farther away from optics member O and outside said predefined distance, respectively, would not cause a detection of high-enough light intensity by detecting member D.

It would also be possible to create a module which comprises (as electronic components) only a detecting member D and no emission member E. In that case, the module could be embodied substantially as the right half of the module 1 shown in Figs. 1 and 2.

Furthermore, it is possible to provide modules which are designed according to the same principles as discussed above, but comprising, in addition to detecting member D, one or more additional electronic components such as additional light detectors, or one or more integrated circuits, or two or more light sources.

The active electronic components comprised in a module (such as emission member E and detecting member D in the example of Fig. 1) can be packaged or unpackaged electronic components. For contacting substrate P, technologies such as wire-bonding or flip chip technology or any other known surface mount technologies may be used, or even conventional through-hole technology.

Fig. 3 shows a schematical cross-sectional view of wafers for forming a wafer stack for manufacturing a multitude of modules as shown in Fig. 1. It is possible to manufacture such modules 1 (practically) completely on wafer-scale, of course with a subsequent separation step. Although Figs. 3 and 4 only show provisions for three modules 1, there will usually be in one wafer stack provisions for at least 10, rather at least 30 or even more than 50 modules in each lateral direction. Typical dimensions of each of the wafers are: laterally at least 5 cm or 10 cm, and up to 30 cm or 40 cm or even 50 cm; and vertically (measured with no components arranged on substrate wafer PW) at least 0.2 mm or 0.4 mm or even 1 mm, and up to 6 mm or 10 mm or even 20 mm.

Four wafers are sufficient for manufacturing a multitude of modules as shown in Fig. 1: A substrate wafer PW, a spacer wafer SW, an optics wafer OW and a baffle wafer BW. Each wafer comprises a multitude of the corresponding members comprised in the corresponding module 1 (cf. Figs. 1 and 2), usually arranged on a rectangular lattice, typically with a little distance from each other for a wafer separation step.

Substrate wafer PW can be a PCB assembly comprising a PCB of standard PCB materials, provided with solder balls 7 on the one side and with active optical components (E and D) soldered to the other side. The latter can be placed on substrate wafer PW by pick-and-place using standard pick-and-place machines.

In order to provide maximum protection from detecting undesired light, all wafers PW, SW, OW, BW can substantially be made of a material substantially non-transparent for light detectable by detecting members D, of course except for transparent areas such as transparent portions t and transparent regions 3.

Wafers SW and BW and possibly also all or a portion of wafer OW can be produced by replication. In an exemplary replication process, a structured surface is embossed into a liquid, viscous or plastically deformable material, then the material is hardened, e.g., by curing using ultraviolet radiation or heating, and then the structured surface is removed. Thus, a replica (which in this case is an negative replica) of the structured surface is obtained. Suitable materials for replication are, e.g., hardenable (more particularly curable) polymer materials or other replication materials, i.e. materials which are transformable in a hardening step (more particularly in a curing step) from a liquid, viscous or plastically deformable state into a solid state. Replication is a known technique, cf., e.g., WO 2005/083789 A2 for more details about this.

In case of optics wafer OW, replication or molding may be used for obtaining the non-transparent portions (blocking portions b). It would also be possible to provide holes, where transparent portions t are supposed to be, by drilling or by etching.

Subsequently, a so-obtained precursor wafer is provided with lens members L, so as to yield optics wafer OW. This may be accomplished by means of replication, e.g., forming lens members L as a unitary parts, e.g., as described in US 2011/0043923 A1. The lens members L can, however, also be manufactured starting from a semi-finished part being a wafer comprising transparent elements 6 within holes by which transparent portions t are defined. This can be particularly useful when the lens members L each describe at least one apex, and those apices are located outside a vertical cross-section of the optics wafer OW. Such a semi-finished part is (usually and in the exemplary case shown in the figures) a flat disk-like wafer having no holes penetrating the wafer in the transparent portions t and having virtually no or only shallow surface corrugations, such surface corrugations usually being concave, i.e. not extending beyond the wafer surface as described by the blocking portions b.

A semi-finished part like that can be obtained starting from a flat precursor wafer (typically made of one material) having holes or openings where the transparent portions are supposed to be and then filling the holes with transparent material, e.g., using a dispensing process, and either filling the holes in the precursor wafer one-by-one, e.g., using a dispenser such as used for underfilling processes in flip-chip technology or the like, or by filling several holes at once, e.g., using a squeegee process (e.g. as known from screen printing) or a dispenser with several hollow needles outputting material. During the dispensing, the wafer can be placed on a flat support plate, e.g., made of a silicone. Care has to be taken order to prevent the formation of air bubbles or cavities in the dispensed material, since this would degrade the optical properties of the lens members L to be produced. E.g., one can carry out the dispensing in such a way that wetting of the wafer material starts at an edge formed by the wafer and an underlying support plate (or in a place close to such an edge), e.g., by suitably guiding a hollow needle outputting the material close to such an edge. Subsequently, the dispensed material is cured, e.g., by heat or UV radiation, so as to obtain hardened transparent material.

Convex meniscuses possibly formed this way can be flattened by polishing, so as to obtain a transparent element 6 having parallel surfaces adjusted to the wafer thickness. Then, by means of replication, lens elements 5 are applied to typically both sides (top and button side) of wafer OW. In case of concave meniscuses of the transparent elements, the replication can take place on these, wherein the amount of applied replication material might have to be adjusted accordingly.

As has already been mentioned, it is generally possible to provide that said spacer wafer SW and/or said baffle wafer BW are obsolete in the sense that a particular kind of optics wafer is provided. Namely an optics wafer ("combined optics wafer") which incorporates the features and functionalities of said spacer wafer SW and/or said baffle wafer BW. Producing such a "combined optics wafer" may be accomplished using a particular precursor wafer and, manufactured based thereon, a particular semi-finished part. Such a precursor wafer and semi-finished part, respectively, has at least one structured surface, usually having protrusions extending vertically beyond at least one of the two surfaces of transparent elements to be provided in precursor wafer and present in the semi-finished part, respectively.

In Fig. 5, an example of a semi-finished part ow' with one structured surface is schematically illustrated. This example for a semi-finished part ow' can be used for manufacturing an optics wafer ("combined optics wafer") and can be understood as a combination of an optics wafer OW and a spacer wafer SW.

It is readily deduced from Fig. 5, what a semi-finished part could look like when it would be used for manufacturing a module shown in Fig. 1. Looking upon wafers OW and SW (or wafers OW and BW, or wafers OW and SW and BW) in Fig. 4 as one single part it can be readily visualized what a corresponding optics wafer ("combined optics wafer") for manufacturing a module according to Fig. 1 and also a corresponding semi-finished part would look like. Fig. 6 schematically illustrates, a cross-sectional view of an opto-electronic module comprising a combined optics member. This opto-electronic module corresponds to the one of Fig. 1, only neither separation member S nor baffle member B are separate from optics member O. They are both comprised in optics member O. Separation member S and baffle member B can both be manufactured together, in a single process, with blocking portion b of optics member O.

In order to form a wafer stack 2, the wafers are aligned and bonded together, e.g., by gluing, e.g., using a heat-curable epoxy resin. It is usually a critical point to ensure that each active optical component (such as detecting members D and emission members E on the substrate wafer PW) is sufficiently accurately allocated with a corresponding passive optical component (such as lens members L of the optics wafer OW).

Fig. 4 shows a cross-sectional view of a so-obtained wafer stack 2 for manufacturing a multitude of modules 1 as shown in Fig. 1. The thin dashed rectangles indicate where separation takes place, e.g., by means of using a dicing saw.

The fact that most alignment steps are carried out on wafer level makes it possible to achieve a good alignment (in particular of members D and E with respect to members L) in a rather simple and very fast way. The overall manufacturing process is very fast and precise. Due to the wafer-scale manufacturing, only a very small number of production steps is required for manufacturing a multitude of modules 1.

List of Reference Symbols

1	opto-electronic module, proximity sensor
2	wafer stack
3	transparent region
4	opening
5	optical structure, lens element
6	transparent element
7	solder ball
9	printed circuit board
10	electronic device, smart phone
b	blocking portion, non-transparent portion
B	baffle member
BW	baffle wafer
D	detecting member, detector, photo diode
E	emission member, light emitter, light-emitting diode
L	passive optical component, lens member
O	optics member
ow'	semi-finished part
OW	optics wafer
P	substrate

PW substrate wafer

s1,s2,... refers to a sectional view

S separation member

SW spacer wafer

t transparent portion

Patent Claims:

1. A method for manufacturing opto-electronic modules, said method comprising the steps of

a) providing a substrate wafer on which a multitude of detecting members are arranged;

b) providing a spacer wafer;

c) providing an optics wafer, said optics wafer comprising a multitude of transparent portions transparent for light generally detectable by said detecting members and at least one blocking portion for substantially attenuating or blocking incident light generally detectable by said detecting members;

d) preparing a wafer stack in which said spacer wafer is arranged between said substrate wafer and said optics wafer such that said detecting members are arranged between said substrate wafer and said optics wafer.

2. The method according to claim 1, wherein step a) comprises the step of

a1) placing said detecting members on said substrate wafer by pick-and-place.

3. The method according to claim 1 or claim 2, comprising the step of manufacturing said spacer wafer and said at least one blocking portion as a unitary part.

4. The method according to one of claims 1 to 3, wherein each of said multitude of transparent portions comprises at least one passive optical component comprising at least one optical structure each, in particular wherein each of said multitude of transparent portions comprises at least one lens member comprising at least one lens element each.

5. The method according to claim 4, further comprising the step of

c1) manufacturing said passive optical components by means of replication.

6. The method according to one of claims 1 to 5, wherein said spacer wafer is made of a material which substantially attenuates or blocks light generally detectable by said detecting members.

7. The method according to one of claims 1 to 6, wherein a multitude of emission members for emitting light generally detectable by said detecting members is arranged on said substrate wafer such that a multitude of neighboring emission members and detecting members are present on said substrate wafer.

8. The method according to claim 7, wherein said multitude of passive optical components comprises one plurality of passive optical components associated with one of said emission members each and another plurality of passive optical components associated with one of said detecting members each.

9. The module according to claim 7 or claim 8, wherein said spacer wafer is structured and arranged such that it reduces optical cross-talk between said emission members and said detecting members.

10. The method according to one of claims 1 to 9, comprising the step of

h) obtaining said spacer wafer by means of a replication process.

11. The method according to one of claims 1 to 10, wherein said opto-electronic modules are proximity sensors.

12. The method according to one of claims 1 to 11, further comprising the step of

e) providing said substrate wafer with solder balls on that side of the substrate sensor which is opposed to that side of the substrate member on which said detecting members are arranged.

13. The method according to one of claims 1 to 12, further comprising the step of

f) separating said wafer stack into a multitude of separate modules each comprising

— a portion of said substrate wafer;

— at least one of said detecting members;

— a portion of said spacer wafer;

— at least one of said transparent portions;

— a portion of said blocking portion.

14. The method according to one of claims 1 to 13, further comprising the step of

g) providing a baffle wafer arranged next to said optics wafer on that side of said optics wafer which is opposed to that side of said optics wafer on which said spacer wafer is arranged, said baffle wafer comprising a multitude of transparent regions;

wherein step d) is replaced by the step of

d') preparing a wafer stack in which said spacer wafer is arranged between said substrate wafer and said optics wafer such that said detecting members are arranged between said substrate wafer and said optics wafer, and wherein said optics wafer is arranged between said baffle wafer and said spacer wafer.

15. The method according to claim 14, comprising the step of manufacturing said blocking portion and said spacer wafer as a unitary part.

16. The method according to one of claims 1 to 15, wherein said substrate wafer substantially is a printed circuit board assembly.

17. An opto-electronic module comprising

— a substrate;

— an optics member arranged generally parallel to said substrate;

— a detecting member arranged between said substrate and said optics member, mounted on said substrate, for detecting light having passed through said optics member;

— a separation member arranged between said substrate and said optics member;

wherein said optics member comprises at least one transparent portion transparent for light generally detectable by said detecting member and at least one blocking portion for substantially attenuating or blocking incident light generally detectable by said detecting member.

18. The module according to claim 17, said transparent portion comprising at least one passive optical component, more particularly at least one lens member.

19. The module according to claim 18, said at least one passive optical component comprising at least one optical structure, wherein said at least one optical structure is at least one of made of a hardened hardenable material and obtained using a replication process.

20. The module according to one of claims 17 to 19, wherein said substrate, said optics member and said separating member are of generally block- or plate-like shape, at least said separating member having at least one hole.

21. The module according to one of claims 17 to 20, wherein said optics member and said separation member are combined in one member, in particular wherein said at least one blocking portion and said separation member are manufactured as a unitary part.

22. The module according to one of claims 17 to 21, wherein lateral dimensions of

— said substrate;

— said optics member;

— said separation member;

are substantially identical.

23. The module according to according to one of claims 17 to 22, further comprising an emission member for emitting light generally detectable by said detecting member.

24. The module according to claim 23, wherein at least a portion of said separation member is arranged between said emission member and said detecting member for reducing optical cross-talk between said emission member and said detecting member.

25. The module according to claim 23 or claim 24, wherein said detecting member is encircled by said separating member, and wherein said emission member is encircled by said separating member.

26. The module according to one of claims 23 to 25, wherein said optics member comprises at least a first and a second passive optical components comprising at least one optical structure each, in particular, wherein said optics member comprises at least a first and a second lens members comprising at least one lens element each.

27. The module according to one of claims 23 to 26, wherein said emission member, said optics member and said detecting member are structured and arranged such, that when light emitted from said emission member having passed said at least one transparent portion and having been reflected by a surface located outside the module and having passed said at least one transparent portion again is detected by said detecting member, an amount of the so-detected light depends on a distance of said surface to said optics member.

28. The module according to one of claims 17 to 27, wherein said separation member is made of a material which substantially attenuates or blocks light generally detectable by said detecting member.

29. The module according to one of claims 17 to 28, wherein said separation member is at least one of made of a hardened hardenable material and obtained using a replication process.

30. The module according to one of claims 17 to 29, wherein said substrate provides at least one electrical connection from said detection member across said substrate.

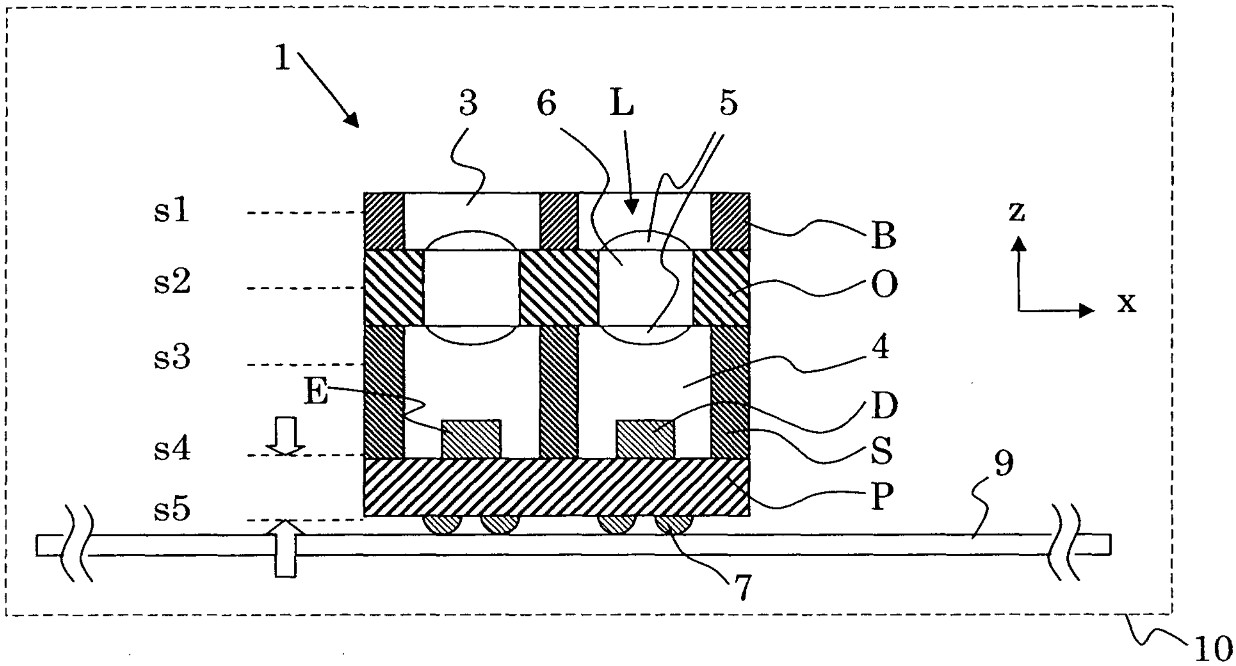
31. The module according to one of claims 17 to 30, wherein said substrate is a printed circuit board assembly.

32. The module according to one of claims 17 to 31, being a proximity sensor.

33. An appliance comprising a multitude of modules according to one of claims 17 to 32, the appliance comprising a substrate wafer, an optics wafer, a spacer wafer, wherein the multitude of substrates is comprised in said substrate wafer, the multitude of optics members is comprised in said optics wafer, the multitude of separation members is comprised in said spacer wafer.

34. An electronic device comprising a printed circuit board and a module according to one of claims 17 to 32 mounted on said printed circuit board.

35. The device according to claim 34, wherein the device is a hand-held communication device.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6
L
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s1
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z
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Fig. 1

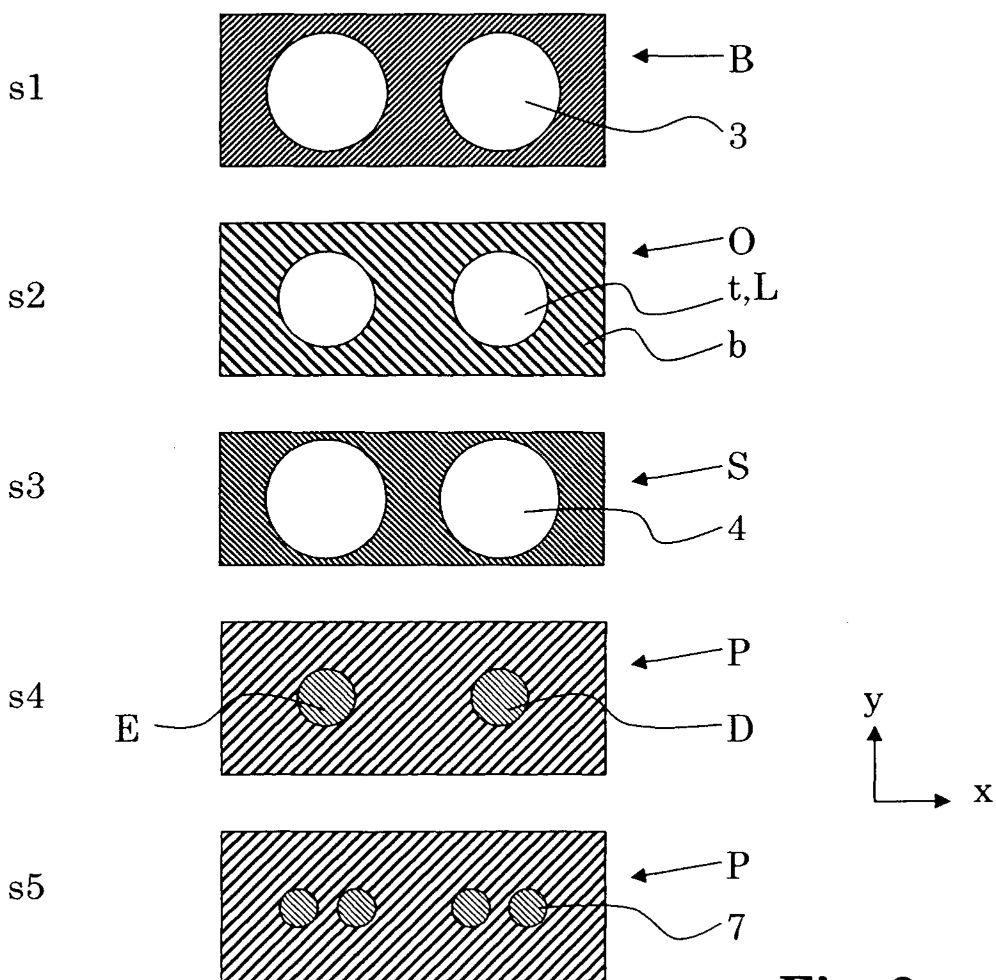
s1
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Fig. 2

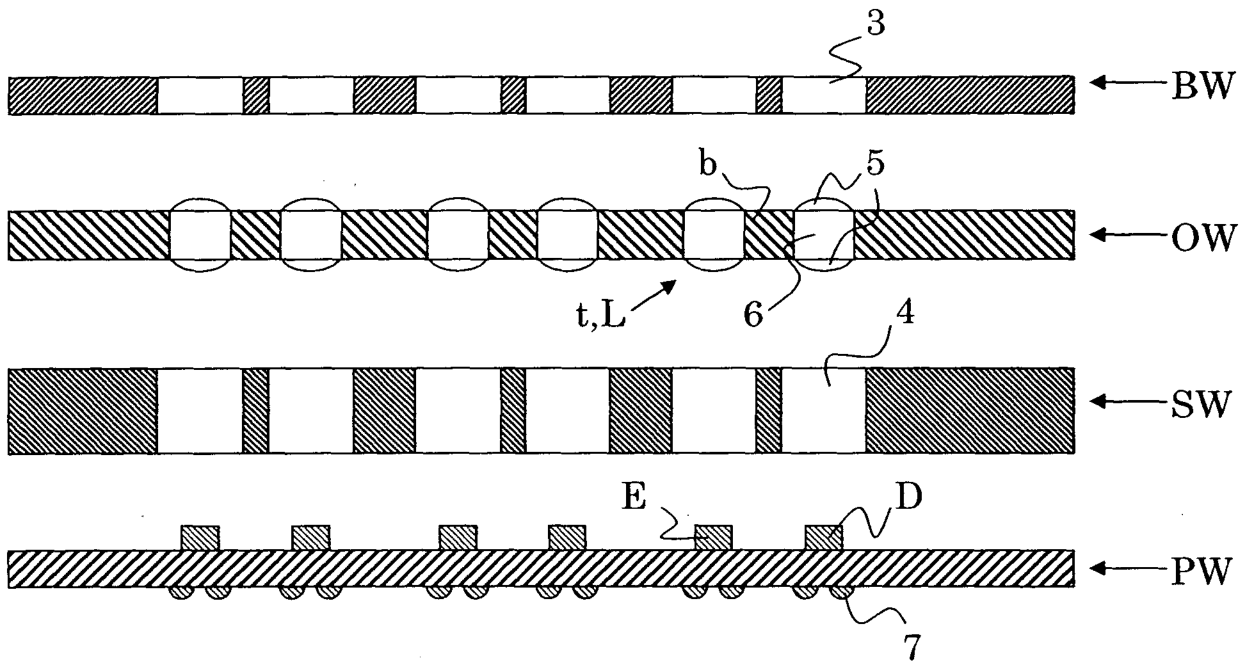

Fig. 3

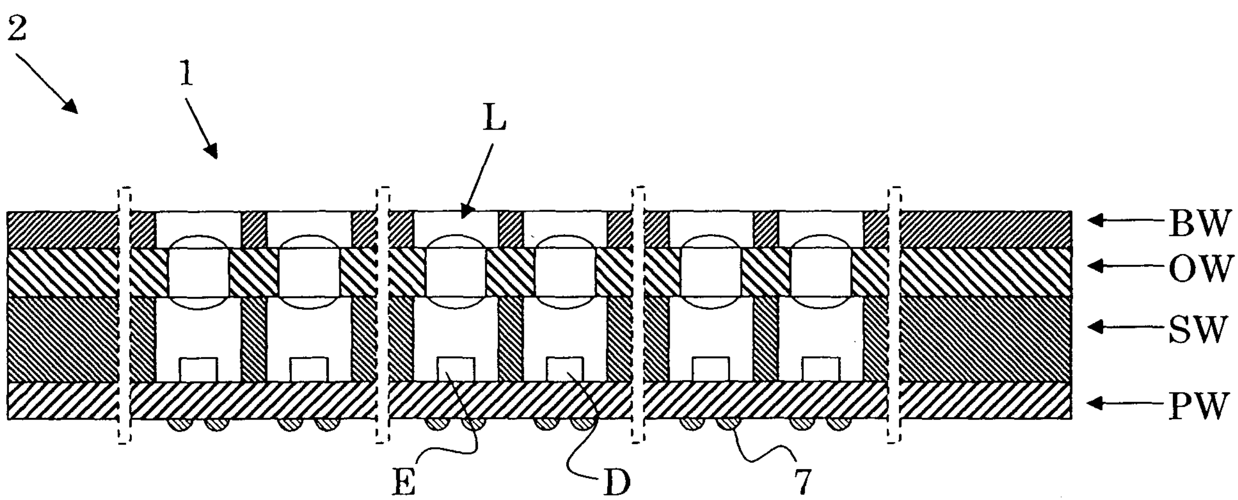

Fig. 4

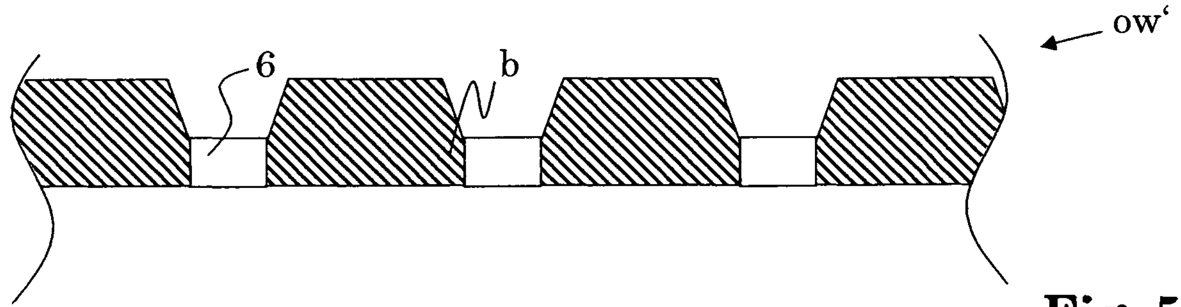

Fig. 5

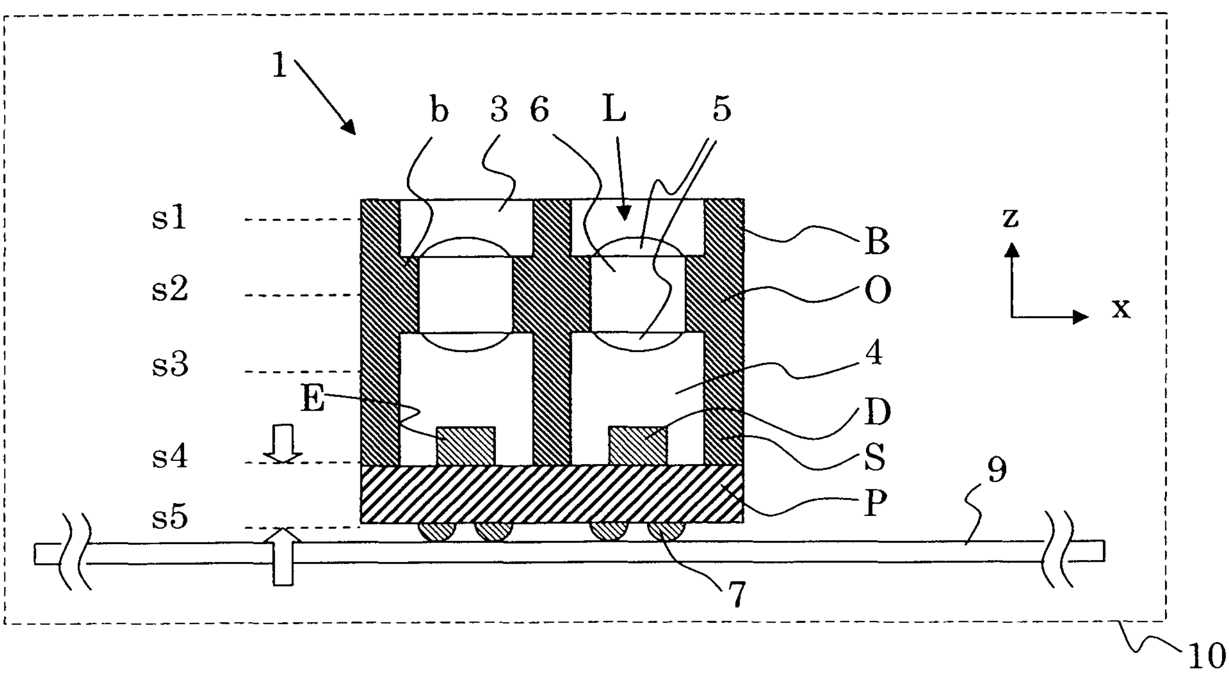

Fig. 6