optical components and the substrate wafer is provided. In particular in the latter case, electrical contacts of the active optical components may also serve as electrical contacts of the opto-electronic module.

Thus, in the sixth aspect of the invention, the following method may be provided:

A method according to the general aspect of the invention, wherein the wafer stack comprises means for ensuring a well-defined distance between said active optical components and said passive optical components, the method comprising,

— in case said means are comprised in said optics wafer, the steps of

f) providing said optics wafer, said optics wafer comprising, as said means, vertical protrusions for ensuring said well-defined distance between said active optical components and said passive optical components; and

h) attaching said active optical components to said wafer stack;

wherein step h) is not carried out before step f) is carried out;

— in case said means are not comprised in said optics wafer, the steps of

g1) providing said optics wafer; and

g2) providing, as said means, at least one spacer wafer for ensuring a well-defined distance between said active optical components and said passive optical components;

h') attaching said active optical components to said wafer stack;

wherein step h') is not carried out before steps g1) and g2) are carried out.

Further embodiments and advantages emerge from the dependent claims and the figures.

printed circuit board on which an active optical component E is mounted. The printed circuit board (PCB) can more specifically also be referred to as an interposer. The active optical component E can in particular be an emission member E for emitting light, in particular for emitting light flashes (high-intensity short light pulses), e.g., a light-emitting diode (LED). Electrical contacts of emission member E (not shown in Fig. 1) 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 at substrate member P, which are not or which are at a later time provided with solder balls or conductive glue.

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 or a photo camera. In particular, device 10 can be a smart phone. Module 1 is particularly suitable for such applications because it can be manufactured having a particularly small size.

Spacer member S has an opening 4 in which emission member E is arranged. Emission member E is laterally encircled by spacer member S.

Spacer member S may fulfill several tasks. It can ensure a well-defined distance between substrate member 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 to the outside of module 1. Furthermore, spacer member S forms a portion of the outside walls of module 1. In particular if spacer member S is at least substantially non-transparent for light of a specific wavelength range, more particularly for light of wavelengths emittable by emission member E, it can help to inhibit an emission of light from portions of the module 1 from which an emission of light is undesired.

Typically, ~~separating~~ spacer member S is made of a polymer material, in particular of a hardened hardenable or more specifically cured curable polymer material, e.g., of an epoxy resin.

The typically envisaged dimensions of opto-electronic modules 1 described in the present patent application are laterally below 15 mm, more typically between 0.5 mm and 8 mm, more particularly between 1 mm and 5 mm, and vertically below 30 mm, more typically between 1 mm and 15 mm, more particularly between 1.5 mm and 10 mm. But generally, also other dimensions may be applicable.

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 2 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. But generally, also other dimensions may be applicable.

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 embodied as a PCB of standard PCB materials, with a multitude of ~~passive~~ active optical components E mounted thereon on one side, and provided with solder balls 7 on the other one side. The emission members E can be placed on substrate wafer PW by pick-and-place using standard pick-and-place machines well-known in electronics industry.

In order to provide maximum inhibition of light emission from undesired parts of module 1, each of the wafers PW, SW, OW, BW can substantially be made of a material

the invention is embodied in Figs. 17 to 19, wherein substrate wafer S usually will not embody the fourth aspect of the invention.

The active optical components may be packaged or unpackaged. They may be electrically contacted in any of the described ways, wherein wirebonding to the top surface (facing substrate member P) is expected to render the realization of a well-defined and reproducible distance of the active optical component E to the optics member O difficult.

In Fig. 17, it is illustrated that two spacer members S, S' can be provided, spacer member S ensuring a desired vertical distance between substrate member P (and thus active optical component E) and optics member O. Spacer member S may be coated like discussed in conjunction with Fig. 16 and/or may be shaped as discussed in conjunction with Fig. 16. The other spacer member S' is arranged between the two substrate wafers P, P'. It increases a mechanical stability of module 1 and can in particular lead to an increased lifetime of the module by absorbing mechanical (including thermo-mechanical) stress to which the electrical connection between active optical component E and substrate member ~~E~~ P is exposed. In embodiment with (at least) two substrates (P, P'), it can lead to an increased (lateral) alignment accuracy if the electrical connection of the active optical components E to the one substrate wafer (P' in Fig. 17) is created after the active optical components E have been (placed on and) fixed to the other substrate wafer (P in Fig. 17).

In a module 1 with two substrate members P, P', at least one spacer member may be replaced by a correspondingly designed other member, namely a substrate member P or P' or, as illustrated in Fig. 18, by a correspondingly designed optics member O. And/or one spacer member (S') can be dispensed with without a replacement, as illustrated in Fig. 19, wherein in the embodiment of Fig. 19, a tube-shaped sleeve or outer jacket 19 is applied individually to each module after separation. A similar circumferential outer cover may also be applied to any of the other described embodiments. Such a cover can be made of a non-transparent material, and in that case,

Patent Claims:

1. A method for manufacturing a device, the device comprising at least one opto-electronic module, said method comprising the step of

c) creating a wafer stack comprising a first wafer, referred to as substrate wafer, and a second wafer, referred to as optics wafer;

wherein a multitude of active optical components is mounted on said substrate wafer, and said optics wafer comprises a multitude of passive optical components, and wherein each of said opto-electronic modules comprises at least one of said active optical components and at least one of said passive optical components.

2. The method according to claim 1, comprising the step of

e) placing said active optical components on said substrate wafer by means of pick-and-place.

3. The method according to claim 1 or claim 2, wherein the wafer stack comprises means for ensuring a well-defined distance between said active optical components and said passive optical components, the method comprising,

— in case said means are comprised in said optics wafer: the steps of

f) providing said optics wafer, said optics wafer comprising, as said means, vertical protrusions for ensuring said well-defined distance between said active optical components and said passive optical components; and

h) attaching said active optical components to said wafer stack;

wherein step h) is not carried out before step f) is carried out; and

— in case said means are not comprised in said optics wafer: the steps of

g1) providing said optics wafer; and

g2) providing, as said means, at least one spacer wafer for ensuring a well-defined distance between said active optical components and said passive optical components;

h') attaching said active optical components to said wafer stack;

wherein step h) is not carried out before steps g1) and g2) are carried out.

4. The method according to one of claims 1 to 3, wherein said active optical components are light emitting components, and wherein each of said opto-electronic modules comprises exactly one of said light emitting components.

5. The method according to one of claims 1 to 4, wherein said optics wafer comprises at least one portion, referred to as blocking portion, which is at least substantially non-transparent for at least a specific wavelength range, and at least one other portion, referred to as transparent portion, which is at least substantially non-transparent for at least said specific wavelength range.

6. The method according to one of claims 1 to 5, wherein said substrate wafer substantially in full is transparent for at least a specific wavelength range or comprises one or more portions in which it is transparent for at least a specific wavelength range.

7. The method according to one of claims 1 to 6, comprising the step of

j) establishing an electrical connection between each of said active optical components and said substrate wafer.

8. The method according to one of claims 1 to 7, wherein said substrate wafer is a printed circuit board or a printed circuit board assembly.

9. The method according to one of claims 1 to 8, wherein the wafer stack comprises means for ensuring a well-defined distance between said active optical components and said passive optical components, wherein said means are comprised in said optics wafer or comprised in said substrate wafer or are distinct from these, wherein said means are, at least in part, made substantially of a material which is at least substantially non-transparent for at least a specific wavelength range.

10. The method according to one of claims 1 to 9, wherein said active optical components are provided as bare dies.

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

d) separating said wafer stack into a multitude of said opto-electronic modules, each comprising at least one of said passive optical components and, vertically and optically aligned thereto, at least one of said active optical components.

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

k) manufacturing at least a portion of said optics wafer using of replication.

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

l) manufacturing said passive optical components using of replication.

14. The method according to one of claims 1 to 13, wherein each of said passive optical components is associated with at least one of said active optical components.

15. An opto-electronic module, comprising

— a substrate member;

— an optics member;

— at least one active optical component mounted on said substrate member;

— at least one passive optical component comprised in said optics member;

wherein the optics member is directly or indirectly fixed to said substrate member.

16. The module according to claim 15, wherein outer bounds of a vertical silhouette of the opto-electronic module and outer bounds of a vertical silhouette of said optics wafer and of said substrate wafer each describe a substantially rectangular shape.

17. The module according to claim 15 or claim 16, wherein said at least one active optical component is exactly one light-emitting component.

18. The module according to one of claims 15 to 17, wherein said optics member comprises at least one portion, referred to as blocking portion, which is at least substantially non-transparent for at least a specific wavelength range, and at least one other portion, referred to as transparent portion, which is at least substantially non-transparent for at least said specific wavelength range.

19. The module according to one of claims 15 to 18, wherein said substrate member substantially in full is transparent for at least a specific wavelength range or comprises one or more portions in which it is transparent for at least a specific wavelength range.

20. The module according to one of claims 15 to 19, comprising at least one electrical connection between said at least one active optical component and said substrate member.

21. The module according to one of claims 15 to 20, wherein said substrate member is a printed circuit board or a printed circuit board assembly.

22. The module according to one of claims 15 to 21, comprising means for ensuring a well-defined distance between said at least one active optical component and said at least one passive optical component, wherein said means are comprised in said optics member or comprised in said substrate member or are distinct from these, wherein said means are, at least in part, made substantially of a material which is at least substantially non-transparent for at least a specific wavelength range.

23. The module according to one of claims 15 to 22, wherein said at least one active optical component is at least one bare die.

24. The module according to one of claims 15 to 23, wherein said substrate member provides at least one electrical connection from said active optical component across said substrate member.

25. The module according to one of claims 15 to 24, wherein lateral dimensions of said substrate member and of said optics member are substantially identical.

26. The module according to one of claims 15 to 25, wherein said optics member is aligned generally parallel to said substrate member.

27. The module according to one of claims 15 to 26, wherein said substrate member and said optics member are of generally block- or plate-like shape, possibly comprising at least one hole.

28. An appliance comprising a multitude of opto-electronic modules according to one of claims 15 to 27, wherein the appliance comprises a first wafer referred to as substrate wafer and a second wafer referred to as optics wafer, wherein the multitude of substrate members is comprised in said substrate wafer, and the multitude of optics members is comprised in said optics wafer.

29. An electronic device comprising a printed circuit board and and an opto-electronic module according to one of claims 15 to 28 mounted on said printed circuit board.

30. The electronic device according to claim 29, wherein the electronic device is a hand-held communication device or a photographic device.

CLAIMS:

1. An opto-electronic module, comprising:

a substrate member;

an optics member;

at least one active optical component mounted on said substrate member; and

at least one passive optical component comprised in said optics member, the at least one passive optical component redirecting light by at least one of refraction or diffraction, wherein the at least one passive optical component comprises (i) a lens or (ii) a prism having two surfaces arranged for light to pass through to or from the at least one active optical component, wherein the two surfaces are non-parallel to one another;

wherein the optics member is directly or indirectly fixed to said substrate member, and

wherein the substrate member and the optics member are of block- or plate shape, wherein at least one of the following applies:

(i) each of outer bounds of a vertical silhouette of the opto-electronic module and outer bounds of a vertical silhouette of said optics member and of said substrate member describes a rectangular shape;

(ii) lateral dimensions of said substrate member and of said optics member are the same.

2. The module according to claim 1, wherein said at least one active optical component is exactly one light-emitting component.

3. The module according to claim 1, wherein said optics member comprises at least one portion, referred to as blocking portion, which is non-transparent for at least a specific wavelength range, and at least one other portion, referred to as transparent portion, which is transparent for at least said specific wavelength range.

4. The module according to claim 1, comprising at least one electrical connection between said at least one active optical component and said substrate member.

5. The module according to claim 1, wherein said substrate member is a printed circuit board or a printed circuit board assembly.

6. The module according to claim 1, comprising a spacer member for ensuring a defined distance between said at least one active optical component and said at least one passive optical component, wherein said spacer member is comprised in said optics member or comprised in said substrate member or are distinct from these, wherein said spacer member is, at least in part, made of a material which is non-transparent for at least a specific wavelength range.

7. The module according to claim 6 wherein the spacer member comprises a coating.

8. The module according to claim 7 wherein at least one of the following applies:

(a) the coating is a reflective coating;

(b) the coating comprises one or more metal layers;

(c) the coating comprises a dielectrical coating.

9. The module according to claim 7 wherein the spacer member comprises at least one surface facing inside the module, the at least one surface being partially or fully coated by the coating.

10. The module according to claim 1, wherein said at least one active optical component is at least one bare die.

11. The module according to claim 1, wherein said substrate member provides at least one electrical connection from said active optical component across said substrate member.

12. The module according to claim 1, wherein said optics member is aligned parallel to said substrate member.

13. An appliance comprising a multitude of opto-electronic modules according to claim 1, wherein the appliance comprises a first wafer referred to as substrate wafer and a second wafer referred to as optics wafer, wherein the multitude of substrate members is comprised in said substrate wafer, and the multitude of optics members is comprised in said optics wafer.

14. An electronic device comprising a printed circuit board and an opto-electronic module according to claim 1 mounted on said printed circuit board.

15. The electronic device according to claim 14, wherein the electronic device is a hand-held communication device or a photographic device.

16. An opto-electronic module, comprising:

a substrate member;

an optics member;

at least one active optical component mounted on the substrate member; and

at least one passive optical component comprised in the optics member, the at least one passive optical component redirecting light by at least one of refraction or diffraction, wherein the at least one passive optical component comprises (i) a lens or (ii) a prism having two surfaces arranged for light to pass through to or from the at least one active optical component, wherein the two surfaces are non-parallel to one another;

wherein the optics member is directly or indirectly fixed to the substrate member, and

wherein outer bounds of a vertical silhouette of the opto-electronic module and outer bounds of a vertical silhouette of the optics member and of the substrate member each describe a rectangular shape.

17. The module according to claim 16, wherein said at least one active optical component is exactly one light-emitting component.

18. The module according to claim 16, wherein said optics member comprises at least one portion, referred to as blocking portion, which is non-transparent for at least a specific wavelength range, and at least one other portion,

referred to as transparent portion, which is transparent for at least said specific wavelength range.

19. The module according to claim 16, wherein at least one of the following applies:

(a) the module comprises at least one electrical connection between said at least one active optical component and said substrate member;

(b) said substrate member is a printed circuit board or a printed circuit board assembly;

(c) the module comprises a spacer member for ensuring a defined distance between said at least one active optical component and said at least one passive optical component, wherein said spacer member is comprised in said optics member or comprised in said substrate member or are distinct from these, wherein said spacer member is, at least in part, made of a material which is non-transparent for at least a specific wavelength range.

20. The module according to claim 19 wherein the module comprises the spacer member, and the spacer member comprises a coating.

21. The module according to claim 20 wherein at least one of the following applies:

(a) the coating is a reflective coating;

(b) the coating comprises one or more metal layers;

(c) the coating comprises a dielectrical coating.

22. The module according to claim 20 wherein the spacer member comprises at least one surface facing inside the

module, the at least one surface being partially or fully coated by the coating.

23. The module according to claim 16, wherein said substrate member provides at least one electrical connection from said active optical component across said substrate member.

24. The module according to claim 16, wherein lateral dimensions of said substrate member and of said optics member are the same.

25. The module according to claim 16, wherein said optics member is aligned parallel to said substrate member.

26. An appliance comprising a multitude of opto-electronic modules according to claim 16, wherein the appliance comprises a first wafer referred to as substrate wafer and a second wafer referred to as optics wafer, wherein the multitude of substrate members is comprised in said substrate wafer, and the multitude of optics members is comprised in said optics wafer.

27. An electronic device comprising a printed circuit board and an opto-electronic module according to claim 16 mounted on said printed circuit board.

28. The electronic device according to claim 27, wherein the electronic device is a hand-held communication device or a photographic device.

29. An opto-electronic module, comprising:

a substrate member;

an optics member;

at least one active optical component mounted on the substrate member, wherein said at least one active optical component is at least one light emitting component;

at least one passive optical component comprised in the optics member, the at least one passive optical component redirecting light by at least one of refraction or diffraction, wherein the at least one passive optical component comprises (i) a lens or (ii) a prism having two surfaces arranged for light to pass through to or from the at least one active optical component, wherein the two surfaces are non-parallel to one another; and

a spacer member for ensuring a defined distance between the at least one active optical component and the at least one passive optical component, wherein the spacer member is comprised in the optics member or comprised in the substrate member or is distinct from the optics member and from the substrate member,

wherein the optics member is directly or indirectly fixed to the substrate member, wherein at least one of the following applies:

(i) each of outer bounds of a vertical silhouette of the opto-electronic module and outer bounds of a vertical silhouette of said optics member and of said substrate member describes a rectangular shape;

(ii) lateral dimensions of said substrate member and of said optics member are the same.

30. The module according to claim 29, wherein said at least one active optical component is exactly one light-emitting component.

31. The module according to claim 29, comprising at least one electrical connection between said at least one active optical component and said substrate member.

32. The module according to claim 29, wherein said substrate member is a printed circuit board or a printed circuit board assembly.

33. The module according to claim 29, wherein said substrate member provides at least one electrical connection from said active optical component across said substrate member.

34. The module according to claim 29, wherein said optics member is aligned parallel to said substrate member.

35. An electronic device comprising a printed circuit board and an opto-electronic module according to claim 29 mounted on said printed circuit board.

36. The electronic device according to claim 35, wherein the electronic device is a hand-held communication device or a photographic device.

37. The module according to claim 29 wherein the spacer member comprises a coating.

38. The module according to claim 37 wherein at least one of the following applies:

(a) the coating is a reflective coating;

(b) the coating comprises one or more metal layers;

(c) the coating comprises a dielectrical coating.

39. The module according to claim 37 wherein the spacer member comprises at least one surface facing inside the module, the at least one surface being partially or fully coated by the coating.

40. An opto-electronic module, comprising:

a substrate member;

an optics member;

at least one active optical component mounted on said substrate member; and

at least one passive optical component comprised in said optics member, the at least one passive optical component redirecting light by at least one of refraction or diffraction, wherein the at least one passive optical component comprises (i) a lens or (ii) a prism having two surfaces arranged for light to pass through to or from the at least one active optical component, wherein the two surfaces are non-parallel to one another;

wherein the optics member is directly or indirectly fixed to said substrate member,

wherein the substrate member and the optics member are of block- or plate shape, and

wherein said substrate member is transparent for at least a specific wavelength range or comprises one or more portions in which it is transparent for at least a specific wavelength range.

41. An opto-electronic module, comprising:

a substrate member;

an optics member;

at least one active optical component mounted on the substrate member, wherein said at least one active optical component is at least one light emitting component;

at least one passive optical component comprised in the optics member, the at least one passive optical component redirecting light by at least one of refraction or diffraction, wherein the at least one passive optical component comprises (i) a lens or (ii) a prism having two surfaces arranged for light to pass through to or from the at least one active optical component, wherein the two surfaces are non-parallel to one another; and

a spacer member for ensuring a defined distance between the at least one active optical component and the at least one passive optical component, wherein the spacer member is comprised in the optics member or comprised in the substrate member or is distinct from the optics member and from the substrate member,

wherein the optics member is directly or indirectly fixed to the substrate member, and

wherein said optics member comprises at least one portion, referred to as blocking portion, which is non-transparent for at least a specific wavelength range, and at least one other portion, referred to as transparent portion, which is transparent for at least said specific wavelength range.

42. An appliance comprising a multitude of opto-electronic modules each of which comprises:

a substrate member;

an optics member;

at least one active optical component mounted on the substrate member, wherein said at least one active optical component is at least one light emitting component;

at least one passive optical component comprised in the optics member, the at least one passive optical component redirecting light by at least one of refraction or diffraction, wherein the at least one passive optical component comprises (i) a lens or (ii) a prism having two surfaces arranged for light to pass through to or from the at least one active optical component, wherein the two surfaces are non-parallel to one another; and

a spacer member for ensuring a defined distance between the at least one active optical component and the at least one passive optical component, wherein the spacer member is comprised in the optics member or comprised in the substrate member or is distinct from the optics member and from the substrate member,

wherein the optics member is directly or indirectly fixed to the substrate member, and

wherein the appliance comprises a first wafer referred to as substrate wafer and a second wafer referred to as optics wafer, wherein the multitude of substrate members is comprised in said substrate wafer, and the multitude of optics members is comprised in said optics wafer.