



(51) International Patent Classification:

H01L 33/48 (2010.01) *H01L 33/00* (2010.01)
H01L 33/54 (2010.01) *H01L 33/50* (2010.01)
H01L 33/60 (2010.01)

(21) International Application Number:

PCT/EP2016/069906

(22) International Filing Date:

23 August 2016 (23.08.2016)

(25) Filing Language:

English

(26) Publication Language:

English

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(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH,

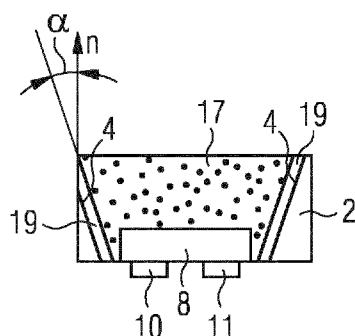
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: METHOD FOR PRODUCING A PLURALITY OF OPTOELECTRONIC DEVICES AND OPTOELECTRONIC DEVICE

FIG 9



(57) Abstract: A method for producing a plurality of optoelectronic devices with the following steps is provided: - providing a premolded frame (1) formed from a plastic material on a carrier (5), said premolded frame (1) having a plurality of frame elements (2), each frame element (2) having an opening (3), penetrating completely through the frame element (2), - attaching at least one semiconductor chip (8) in each opening (3), such that a frame-chip compound is generated, - filling the openings (3) at least partially with a resin (17), and - separating the frame-chip compound such that a plurality of optoelectronic devices is generated. Further, an optoelectronic device is provided.

Description

Method for producing a plurality of optoelectronic devices
and optoelectronic device

5

A method for producing a plurality of optoelectronic devices
and an optoelectronic device are provided.

It is an object of the present application to provide a
10 method for producing a plurality of optoelectronic devices
having improved light out-coupling properties. Furthermore,
it is an object of the present application to provide an
optoelectronic device having improved light out-coupling
properties.

15

These objects are achieved by a method with the steps of
claim 1 and by an optoelectronic device with the features of
claim 7. Preferred embodiments and developments of the method
and the optoelectronic device are given in the respective
20 dependent claims.

During a method for producing a plurality of optoelectronic
devices a premolded frame comprising a plurality of frame
elements is provided on a carrier. The premolded frame is
25 preferably formed from a plastic material, particularly
preferably completely. In particular, the premolded frame is
preferably free from a leadframe.

The premolded frame is particularly preferably manufactured
30 locally spaced apart and/or independently from the rest of
the optoelectronic devices. Particularly preferably, the
premolded frame is alone mechanically stable. The premolded
frame can be manufactured for example by injection molding or

compression molding. One of the following materials is suited to form the premolded frame: polycarbonate, polymethylmethacrylate, epoxy resin.

5 Preferably, each frame element has an opening, which penetrates completely through the frame element. The opening can have a rectangular or round form. Particularly preferably, the frame elements of the premolded frame are all formed in an equal manner.

10

In a next step of the method for producing a plurality of optoelectronic devices, at least one semiconductor chip is attached in each opening, such that a frame-chip compound is generated. During this method step, the semiconductor chip is
15 preferably also fixed to the carrier. For example, the semiconductor chips can be placed within the openings successively. Further, it might be possible that the semiconductor chips are placed within the openings by the help of a batch process.

20

The carrier can comprise a metal plate or can be formed from a metal plate. The metal plate can be a stainless steel plate. Further, the carrier can comprise a thermal release tape or can be formed by a thermal release tape. Furthermore,
25 the carrier can be a compound of a stainless steel plate and a thermal release tape. In this case the stainless steel plate is preferably responsible for the mechanical stability of the carrier, while the release tape has sticking properties for fixing the elements of the finished
30 optoelectronic device, such as the semiconductor chips or the premolded frame. According to a preferred embodiment of the method, the premolded frame and the semiconductor chips are fixed to the thermal release tape.

In a next step of the method, the openings are at least partially filled with a resin. The openings can be filled with the resin by casting. Particularly preferably, the
5 openings are filled completely with the resin, such that the resin terminates flush with a surface of the premolded frame. In order to harden the resin, the resin is cured, for example thermally or by ultraviolet light. As resin a silicone or an epoxy resin or a mixture of these materials can be used.

10

In a next step of the method, the frame-chip compound is particularly preferably separated such that a plurality of optoelectronic devices is generated. During separation the premolded frame is preferably divided in a plurality of frame
15 elements. The optoelectronic devices can be separated by sawing. Preferably, traces of separation are generated on side faces of the frame element by the separation process. For example traces of the saw or traces of the laser separation used for separation of the optoelectronic devices
20 are generated on the side faces of the frame element. Such, the batch process described in this text can be detected at the finished optoelectronic device.

If a compound of a stainless steel plate and a thermal
25 release tape is used as a carrier, the stainless steel plate is preferably detached from the thermal release tape before separation of the optoelectronic devices. After the separation of the optoelectronic devices, the thermal release tape can be removed from each optoelectronic device.

30

According to an embodiment of the method, each opening of the premolded frame is limited by a sidewall, which is inclined and includes an acute angle with a normal of a main face of

the premolded frame. By choosing the value of the acute angle the radiation characteristic of the optoelectronic device can be influenced in a desired manner. Preferably, the acute angle has a value between 25° and 85° inclusive the limits.

5 Particularly preferably, the acute angle has a value between 35° and 65° inclusive the limits.

According to a further embodiment of the method, each opening of the premolded frame is limited by a sidewall, which is
10 curved. For example, the curved sidewall has a parabolic shape.

The number of the sidewalls of the opening depends on the form of the frame element. For example, if the opening has a
15 rectangular form, the opening is preferably limited by four sidewalls. In the case of a round opening, a single sidewall limits the opening.

According to a further preferred embodiment of the method,
20 the semiconductor chip comprises a semiconductor layer sequence with an active zone generating electromagnetic radiation of a first wavelength range during operation of the semiconductor chip. Preferably, the active zone generates visible light, particularly from the blue spectral range.

25

For example, the semiconductor layer sequence is based on a nitride semiconductor compound material. A nitride semiconductor compound material is a semiconductor material comprising nitrogen, as for example the materials from the
30 system $\text{In}_x\text{Al}_y\text{Ga}_{1-x-y}\text{N}$ with $0 \leq x \leq 1$, $0 \leq y \leq 1$ and $x+y \leq 1$. A semiconductor layer sequence based on a nitride semiconductor compound material can, in particular, generate blue light.

The electromagnetic radiation generated within the active zone is preferably emitted from a radiation exit surface of the semiconductor chip. Preferably, the radiation exit surface of the semiconductor chip runs parallel to a rear
5 main face of the semiconductor chip. Particularly preferably, the radiation exit surface and the rear main face of the semiconductor chip are arranged opposite to each other.

Preferably, the semiconductor chip comprises a substrate,
10 which is transparent at least for the electromagnetic radiation generated in the active zone. In this case, side faces of the semiconductor chip are at least partially formed by the substrate and electromagnetic radiation generated within in the active zone is emitted not only through the
15 radiation exit surface of the semiconductor chip, but also through the side faces of the semiconductor chip.

Preferably, the semiconductor layer sequence is arranged in direct contact on the substrate. For example, the
20 semiconductor layer sequence is epitaxially grown on the substrate. In particular, a sapphire substrate or a silicon carbide substrate is suited as a growth substrate for a semiconductor layer sequence based on a gallium nitride material. A sapphire substrate or a silicon carbide substrate
25 is advantageously transparent for blue light.

According to a further embodiment of the method, the semiconductor chip comprises a first electrical contact and a second electrical contact, which are both arranged on a rear
30 main face of the semiconductor chip. The rear main face of the semiconductor chip is preferably arranged opposite to the radiation exit surface of the semiconductor chip. The first electrical contact and the second electrical contact are

intended to provide the active zone with current during operation of the semiconductor chip.

According to a further embodiment of the method, the resin
5 comprises phosphor particles, which convert the electromagnetic radiation of the first wavelength range in electromagnetic radiation of a second wavelength range, which is different from the first wavelength range.

10 For example, one of the following materials is suited for the phosphor particles: garnets doped with rare earths, sulfides doped with rare earths, thiogallates doped with rare earths, aluminates doped with rare earths, silicates doped with rare earths, orthosilicates doped with rare earths, nitrides doped
15 with rare earths, oxinitrides doped with rare earths, chlorosilicates doped with rare earths, silicon nitrides doped with rare earths, sialones doped with rare earths.

Preferably, the phosphor particles convert a part of the
20 electromagnetic radiation of the first wavelength range, which is out of the blue spectral range, into yellow radiation, such that the optoelectronic device emits mixed white light composed of light of the first wavelength range and light of the second wavelength range.

25

For example, the phosphor particles can form a wavelength conversion layer at least on the radiation exit surface of the semiconductor chip by sedimentation. During sedimentation, the phosphor particles are comprised by the
30 uncured liquid resin and fall down onto the semiconductor chip by gravitation, such that they form a wavelength conversion layer at least on the radiation exit surface of

the semiconductor chip. After the sedimentation of the phosphor particles by gravitation, the resin is cured.

Alternatively, the resin can be cured directly after to be
5 filled within the opening. This results in a casting, wherein the phosphor particles are distributed in the whole volume.

Furthermore, it is possible that a wavelength conversion
plate is arranged directly on the radiation exit surface of
10 the semiconductor chip. The wavelength conversion plate can be formed from a resin, preferably from silicone, also having phosphor particles for wavelength conversion in its volume. Furthermore, it is possible that the wavelength conversion
plate is formed from a wavelength conversion ceramic
15 material.

The method described above is particularly suited for the manufacturing of a plurality of semiconductor chips. A semiconductor chip, which can be manufactured by the method
20 described above, is described in the following. All features and embodiments described in connection with the method can also be embodied within the semiconductor chip and vice versa, as far as it is reasonable from a technical point of view.

25

An optoelectronic device preferably comprises a semiconductor chip with a first electrical contact and a second electrical contact on a rear main face of the semiconductor chip. The rear main face of the semiconductor chip is arranged opposite
30 to a radiation exit surface of the semiconductor chip.

Furthermore, the optoelectronic device preferably comprises a frame element formed from a plastic material. The frame

element comprises preferably an opening penetrating completely through the frame element. Preferably, the semiconductor chip is arranged in the opening.

- 5 Preferably, the frame element is responsible for the mechanical stability of the optoelectronic device. Particularly preferably, the optoelectronic device does not comprise a further carrier element, which renders the optoelectronic device mechanically stable. In particular, the
10 optoelectronic device is free of a leadframe. Particularly preferably, the frame element is free of a leadframe.

Furthermore, the optoelectronic device comprises a resin, which is arranged in the opening. Preferably, the resin fills
15 the opening completely, such that a planar surface is formed by the resin and the frame element. Particularly preferably, the resin terminates flush with the frame element.

According to a preferred embodiment of the optoelectronic
20 device, the semiconductor chip is fixed to the frame element solely by the resin. In other words, the resin forms the joining material for fixing the semiconductor chip within the frame element. Particularly preferably, the resin is at least partially freely accessible from a rear main face of the
25 optoelectronic device. Preferably, all gaps between the semiconductor chip and the frame element are filled with the resin. This enhances the stability of the connection between the semiconductor chip and the frame element.

30 The rear main face of the optoelectronic device is arranged opposite to a radiation emitting front face of the optoelectronic device. The rear main face of the

optoelectronic element is preferably suited for mounting to a further element, such as a printed circuit board.

Particularly preferably, the first electrical contact and the
5 second electrical contact are freely accessible, particularly preferably from a rear main face of the optoelectronic device. This makes it advantageously possible to electrically connect the optoelectronic device via its rear main face by the help of the first electrical contact and the second
10 electrical contact. In such a way, bond wires can be avoided, which leads to more reliable electrical properties of the optoelectronic device. Further, it is advantageously possible to solder the optoelectronic device to contact pads of a carrier or a printed circuit board via its first electrical
15 contact and its second electrical contact.

According to a further embodiment of the optoelectronic device, a wavelength conversion layer is applied on the radiation exit surface of the semiconductor chip. Further, it
20 is also possible that the side faces of the semiconductor chip are covered with the wavelength conversion layer.

Particularly preferably, the semiconductor chip comprises a substrate, which is transparent at least for the
25 electromagnetic radiation generated in the active zone, such as a sapphire substrate or a silicone carbide substrate. Such a semiconductor chip emits electromagnetic radiation generated in the active zone not only from its radiation exit surface, but also at least partially from its side faces.

30

Electromagnetic radiation, which is emitted from the side faces of the substrate, impinges on the sidewall of the opening. If the sidewalls are inclined or curved, they can

advantageously act as a reflector for the electromagnetic radiation emitted laterally from the side faces of the semiconductor chip. In such a way, the radiation characteristic of the optoelectronic device can be influenced
5 in a desired manner.

Particularly preferably, the sidewall of the opening is covered with a reflective layer. The reflective layer particularly preferably enhances the reflectivity of the
10 sidewalls for the electromagnetic radiation generated in the active zone. Particularly preferably, the reflective layer is embodied as a specular reflective layer. The reflective layer can be formed by a metal, in particular, by silver. The reflective layer formed from a metal has preferably a
15 thickness between 100 Nanometer and 1000 Nanometer, inclusive the limits. Particularly preferably, the reflective layer formed from a metal has a thickness between 200 Nanometer and 600 Nanometer, inclusive the limits.

20 Further, the reflective layer can be formed from a resin, which comprises reflective particles, in particular titandioxide particles. The reflective layer formed from a resin comprising reflective particles has preferably a thickness between 0.5 Microns and 10 Microns, inclusive the
25 limits. Particularly preferably, the reflective layer formed from a resin comprising reflective particles has a thickness between 2 Microns and 5 Microns, inclusive the limits.

Further preferred embodiments and developments of the
30 invention are described in the following in connection with the Figures.

In connection with the schematic views of Figures 1 to 7, an exemplary embodiment of a method for producing a plurality of optoelectronic devices is described in further detail.

- 5 In connection with the schematic view of Figure 8, a further exemplary embodiment of the method is described.

With the help of the schematic views of Figures 9 to 10 a first exemplary embodiment of an optoelectronic device is
10 described.

In connection with the schematic sectional views of Figures 11 and 12 a further exemplary embodiment of the optoelectronic device is described.

15

In connection with the schematic sectional views of Figures 13 to 15 further exemplary embodiments of the optoelectronic device are described.

- 20 The schematic sectional views of Figures 16 and 17 show further exemplary embodiments of the optoelectronic device.

Equal or similar elements as well as elements of equal function are designated with the same reference signs in the
25 figures. The figures and the proportions of the elements shown in the figures are not regarded as being shown to scale. Rather, single elements, in particular layers, can be shown exaggerated in magnitude for the sake of better presentation.

30

As shown, for example, in the schematic plan view of Figure 1, a premolded frame 1 is provided in a first step of the method according to the exemplary embodiment of Figures 1 to

7. The premolded frame 1 is formed completely from a plastic material and has a plurality of frame elements 2. Each frame element 2 has an opening 3, which is formed in a rectangular manner in the present exemplary embodiment. The openings 3
5 penetrate completely through the frame element 2.

As shown schematically in Figure 2, each opening 3 is limited by a sidewall 4, which has an inclined surface, including an acute angle α with respect to a normal n of a main face of
10 the premolded frame 1. The premolded frame 1 is provided on a carrier 5, which is formed by a compound of a stainless steel plate 6 provided with a thermal release tape 7.

In the next step of the method according to the exemplary
15 embodiment of Figures 1 to 7, which is schematically shown in Figure 3, a plurality of semiconductor light-emitting chips 8 is placed within the openings 3 of the premolded frame 1. In each opening 3 of the premolded frame 1 one semiconductor chip 8 is fixed to the thermal release tape 7.

20

The schematic sectional view of Figure 4 shows exemplarily a semiconductor chip 8, which can be used at present. The semiconductor chip 8 comprises a rear main face 9 provided with a first electrical contact 10 and a second electrical
25 contact 11. The rear main face 9 of the semiconductor chip is arranged opposite to a radiation exit surface 12 of the semiconductor chip 8. Furthermore, the semiconductor chip 8 comprises a semiconductor layer sequence 13 with an active zone 14 generating blue light during operation. The
30 semiconductor layer sequence 13 is epitaxially grown on a transparent substrate 15, such that light generated in the active zone 14 is also emitted from the side faces 16 of the semiconductor chip 8.

In a next step of the method, which is schematically shown in Figure 5, the opening 3 of each frame element 2 is filled with a resin 17, for example by casting. The resin 17 fills the opening 3 completely and terminates flush with the frame elements 2. Also, the liquid resin 17 fills, preferably completely, gaps between the semiconductor chips 8 and the respective frame element 2. The resin 17 is cured immediately after filling the resin 17 in the openings. The cured resin 17 fixes the semiconductor chips 8 to the frame elements 2.

The resin 17 comprises wavelength converting phosphor particles, which convert the blue light of the semiconductor chip 8 partially into yellow light. Since the curing of the resin 17 is performed immediately after filling the resin 17 in the openings 3, the phosphor particles are distributed within the whole volume of the resin 17.

In a next step of the method, which is shown in Figure 6, the stainless steel plate 6 is removed from the thermal release tape 7. Then, the optoelectronic devices are separated by sawing along separation lines 18 running through the premolded frame 1 (Figure 7).

Finally, the thermal release tape 7 is removed from the optoelectronic devices such that the first electrical contact 10 and the second electrical contact 11 are freely accessible (not shown). Also, the cured resin 17 is freely accessible at a rear main face of the optoelectronic device.

According to the method of the exemplary embodiment of Figure 8, the resin 17 is not cured immediately after to be filled in the openings 3, as described in connection with Figure 5.

Rather, the resin 17 stays in a liquid uncured state in a first instance, such that the phosphor particles form a wavelength conversion layer 22 on a radiation exit surface 12 of the semiconductor chips 8 by sedimentation. After the sedimentation of the phosphor particles by gravitation, the resin 17 is cured and a stable chip-frame compound is achieved. Then, the method can be prosecuted further as already described in connection with Figures 6 and 7.

The optoelectronic device according to the exemplary embodiment of Figures 9 and 10 comprises a frame element 2 formed from a plastic material. The frame element 2 is free from a leadframe and completely formed out of the plastic material. The frame element 2 has a rectangular opening 3 limited by four inclined sidewalls 4, which include an acute angle α with a normal n of the frame element 2. On the sidewalls 4 of the opening 3, a reflective layer 19, preferably formed from silver, is deposited.

In the opening 3 of the frame element 2, a semiconductor chip 8 is arranged. The semiconductor chip 8 has two electrical contacts 10, 11, which are freely accessible from a rear main face of the optoelectronic device. The opening 3 of the frame element 2 is completely filled with the resin 17. The resin 17 is partially freely accessible from a rear main face of the optoelectronic device. The resin 17 comprises in its whole volume phosphor particles converting electromagnetic radiation of the first wavelength range emitted by the semiconductor chip 8 in electromagnetic radiation of the second wavelength range, such that the optoelectronic device emits white light during operation. The white light is composed of unconverted primary electromagnetic radiation of

the semiconductor chip 8 and electromagnetic radiation converted by the phosphor particles.

Figure 10 shows a perspective schematic view of the optoelectronic device of Figure 9. As can be seen, the optoelectronic device, the frame element 2 and the opening 3 have a rectangular form. The frame element 2 forms a rectangular frame surrounding the semiconductor chip 8 and its radiation exit surface 12 completely.

The optoelectronic device according to the exemplary embodiment of Figure 11 has, in contrast to the optoelectronic device according to the exemplary embodiment of Figures 9 and 10, a wavelength conversion plate 20, which is directly arranged on the radiation exit surface 12 of the semiconductor chip 8. The wavelength conversion plate 20 can be formed from a ceramic wavelength conversion material or from a silicone comprising phosphor particles. The opening 3 of the frame element 2 is filled with a resin 17.

Figure 12 depicts the section indicated in Figure 11, in order to explain the function of the inclined sidewalls 4 of the openings 3 in further detail. Light rays represented by the arrows, which are emitted from side faces 16 of the transparent substrate 15 of the semiconductor chip 8, impinge on the inclined sidewalls 4 of the frame element 2. Due to their slope, the inclined sidewalls 4 reflect the light rays towards a radiation exit surface 21 of the optoelectronic device. This reduces loss of light. By choosing the form of the sidewalls 4 and/or the angle α of the inclined sidewall 4 with the normal n of the frame element 2, a desired radiation characteristics can be achieved.

The optoelectronic devices according to the exemplary embodiments of Figures 13 to 15 all have frame elements 2 with openings 3 that are each limited by an inclined sidewall 4. The sidewalls 4 according to the exemplary embodiments of Figures 13 to 15 all include an acute angle α with a normal n of the frame element 2. However, the angle α of the three exemplary embodiments differ from each other resulting in different radiation characteristics.

10 The sidewalls 4 of the opening 3 of the frame element 2 of the optoelectronic device according to Figure 13 encloses an acute angle α having a value about 70° with a normal n of the frame element 2. This leads to a reflection of light rays emitted from side faces 16 of the semiconductor chip 8 by the sidewalls 4 resulting in converging light rays as indicated by the arrows in the Figure.

The sidewalls 4 of the opening 3 of the frame element 2 of the optoelectronic device according to Figure 14 encloses an acute angle α having a value of about 45° with a normal n of the frame element 2. This leads to a reflection of light rays emitted from side faces 16 of the semiconductor chip 8 by the sidewalls 4 resulting in parallel light rays as indicated by the arrows in the Figure.

25

The sidewalls 4 of the opening 3 of the frame element 2 of the optoelectronic device according to Figure 15 encloses an acute angle α having a value of about 25° with a normal n of the frame element 2. This leads to a reflection of light rays emitted from side faces 16 of the semiconductor chip 8 by the sidewalls 4 resulting in diverging light rays as indicated by the arrows in the Figure.

30

The optoelectronic device according to the exemplary embodiment of Figure 16 has, in contrast to the optoelectronic device of the exemplary embodiment of Figure 11, a frame element 2 with curved sidewalls 4. Furthermore, the side faces 16 of the semiconductor chip 8 are also provided with a wavelength conversion layer 22.

Such an optoelectronic device can be particularly used as a low cost flash.

The optoelectronic device according to the exemplary embodiment of Figure 17 has, in contrast to the optoelectronic device according to the exemplary embodiment of Figure 16, a frame element 2 with a greater thickness and an opening 3 with sidewalls 4 having a greater area than the sidewalls 4 of the opening 3 of the optoelectronic device of Figure 16. Further, the sidewalls 4 have a steeper slope such that a region of the sidewall 4 spaced apart from the semiconductor chip 8 is substantially parallel to a normal n' of the radiation exit surface 12 of the semiconductor chip 8. This optoelectronic device has, in particular, a radiation characteristic with a very narrow angle of the emitted electromagnetic radiation.

The invention is not restricted to the exemplary embodiments by the description on the basis of said exemplary embodiments. Rather, the invention encompasses any novel feature and also any combination of features, which in particular includes any combination of features in the patent claims, even if this feature or this combination itself is not explicitly specified in the patent claims or exemplary embodiments.

Reference signs

	1	premolded frame
	2	frame elements
5	3	opening
	4	sidewall
	α	acute angle
	n	normal
	5	carrier
10	6	stainless steel plate
	7	thermal release tape
	8	semiconductor chip
	9	real main face of the semiconductor chip
	10	first electrical contact
15	11	second electrical contact
	12	radiation exit surface of the semiconductor chip
	13	semiconductor layer sequence
	14	active zone
	15	substrate
20	16	sidefaces of the semiconductor chip
	17	resin
	18	separation line
	19	reflective layer
	20	wavelength conversion plate
25	21	radiation exit surface of the optoelectronic device
	22	wavelength conversion layer
	n'	normal of the radiation exit surface

Claims

1. Method for producing a plurality of optoelectronic
5 devices having the steps:
- providing a premolded frame (1) formed from a plastic material on a carrier (5), said premolded frame (1) having a plurality of frame elements (1), each frame element (2) having an opening (3), penetrating completely through the
10 frame element (2),
 - attaching at least one semiconductor chip (8) in each opening (3), such that a frame-chip compound is generated,
 - filling the openings (3) at least partially with a resin (17), and
 - 15 - separating the frame-chip compound such that a plurality of optoelectronic devices is generated.
2. The method according to claim 1, wherein each opening (3) of the premolded frame (1) is limited by a sidewall (4), said
20 sidewall (4) being inclined and including an acute angle (α) with a normal (n) of a main face of the premolded frame (1) or said sidewall (4) being curved.
3. The method according to any of the preceding claims,
25 wherein each semiconductor chip (8) comprises:
- a first electrical contact (10) and a second electrical contact (11) on a rear main face (9) of the semiconductor chip (8), said rear main face (9) being arranged opposite to a radiation exit surface (12) of the semiconductor chip (8),
 - 30 - a semiconductor layer sequence (13) with an active zone (14) generating electromagnetic radiation of a first wavelength range during operation of the semiconductor chip (8), and

- a substrate (15), which is transparent at least for the electromagnetic radiation generated in the active zone (14).

4. The method according to any of the preceding claims,
5 wherein the resin (17) comprises phosphor particles, which convert the electromagnetic radiation of the first wavelength range in electromagnetic radiation of a second wavelength range.

10 5. The method according to the preceding claims, wherein the phosphor particles form a wavelength conversion layer (22) at least on a radiation exit surface (12) of the semiconductor chip (8) by sedimentation.

15 6. The method according to any of the preceding claims, wherein a wavelength conversion plate (20) is arranged directly on the radiation exit surface (12) of the semiconductor chip (8).

20 7. Optoelectronic device comprising:
- a semiconductor chip (8) with a first electrical contact (10) and a second electrical contact (11) on a rear main face (9) of the semiconductor chip (8), said rear main face (9) being arranged opposite to a radiation exit surface (12) of
25 the semiconductor chip (8),
- a frame element (2) formed from a plastic material with an opening (3) penetrating completely through the frame element (2), wherein the semiconductor chip (8) is arranged in the opening (3), such that the first electrical contact (10) and
30 the second electrical contact (11) are freely accessible, and
- a resin (17) arranged in the opening (3).

8. The optoelectronic device according to claim 7, wherein the semiconductor chip (8) is fixed to the frame element (2) solely by the resin (17).

5 9. The optoelectronic device according any of claims 7 to 8, wherein the resin (17) is at least partially freely accessible from a rear main face of the optoelectronic device.

10 10. The optoelectronic device according to any of claims 7 to 9, wherein each opening (3) of the frame element (2) is limited by a planar inclined sidewall (4) including an acute angle (α) with a normal (n) of a main face of the frame element (2).

15

11. The optoelectronic device according to any of claims 7 to 9, wherein each opening (3) of the frame element (2) is limited by a curved sidewall (4).

20 12. The optoelectronic device according to any of claims 7 to 11, wherein each semiconductor chip (8) comprises:

- a semiconductor layer sequence (13) with an active zone (14) generating electromagnetic radiation of a first wavelength range during operation of the semiconductor chip

25

(8), and

- a substrate (15), which is transparent at least for the electromagnetic radiation generated in the active zone (14).

13. The optoelectronic device according to any of claims 7 to
30 12, wherein the resin (17) comprises phosphor particles, which convert the electromagnetic radiation of the first wavelength range in electromagnetic radiation of a second wavelength range.

14. The optoelectronic device according to any of claims 7 to 13, wherein a wavelength conversion plate (20) is arranged directly on the radiation exit surface (12) of the semiconductor chip (8).

15. The optoelectronic device according to any of claims 7 to 14, wherein the sidewall (4) of the opening (3) is covered with a reflective layer (19).

16. The optoelectronic device according to any of claims 7 to 15, wherein the reflective layer (19) is formed by a metal, in particular by silver.

17. The optoelectronic device according to any of claims 7 to 15, wherein the reflective layer (19) is formed by a resin comprising reflective particles, in particular titandioxide particles.

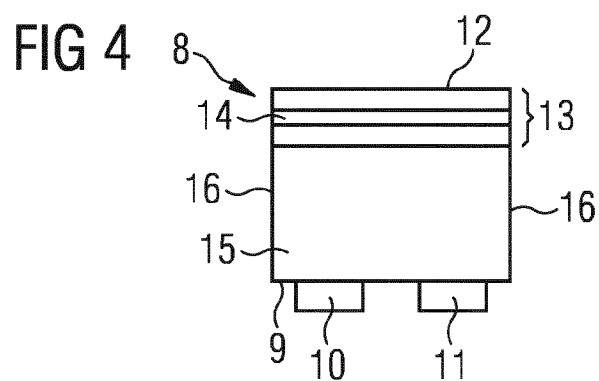
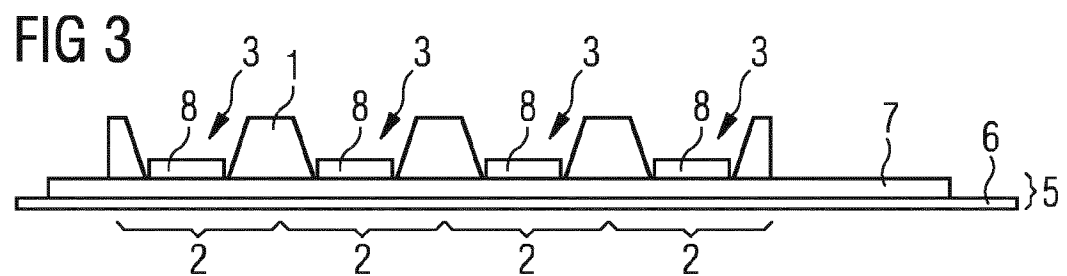
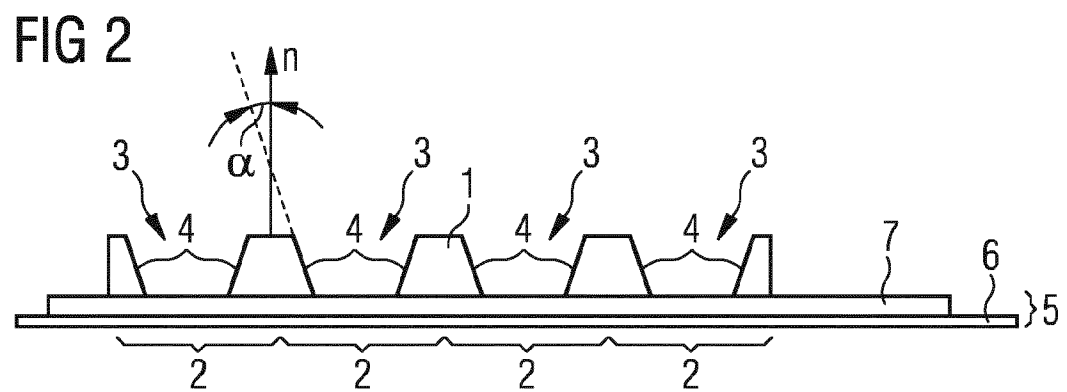
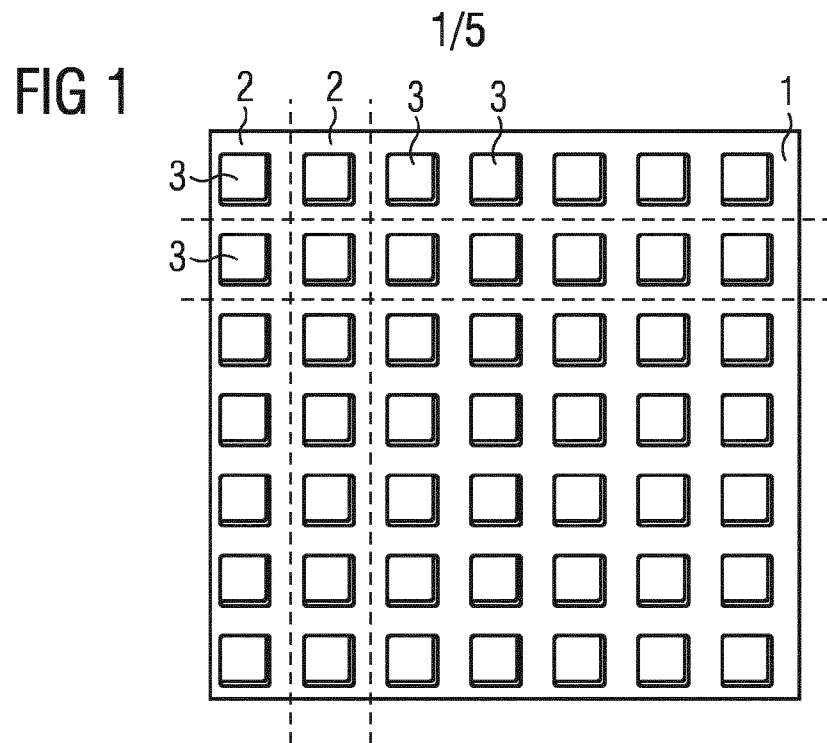


FIG 5

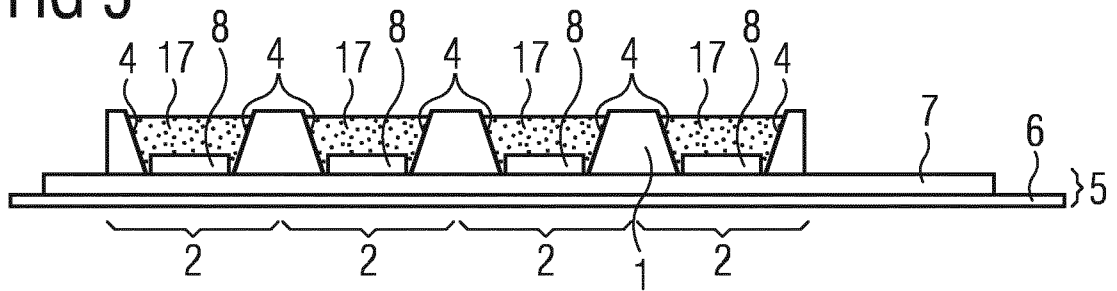


FIG 6

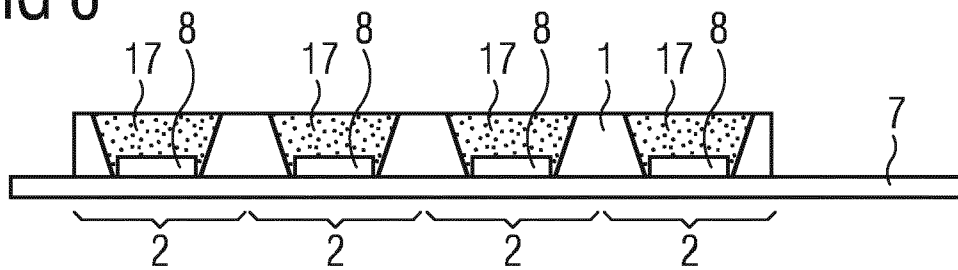


FIG 7

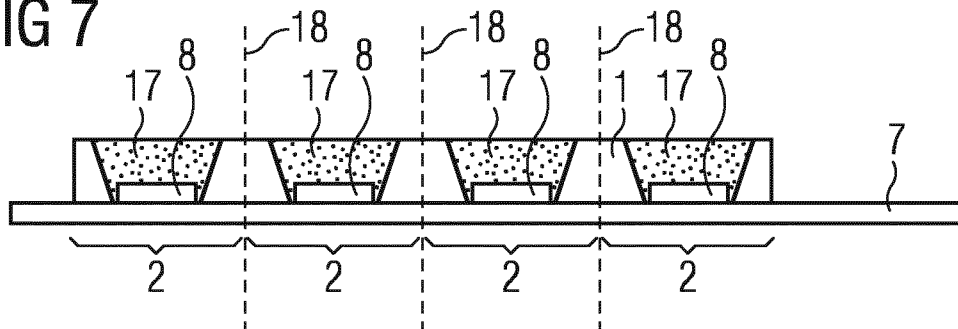


FIG 8

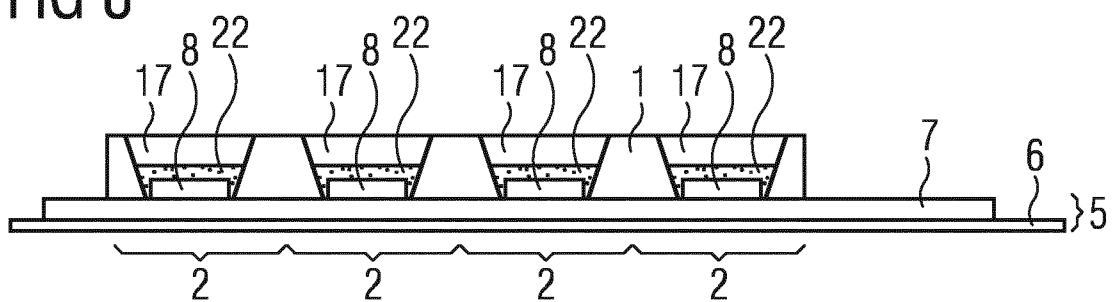


FIG 9

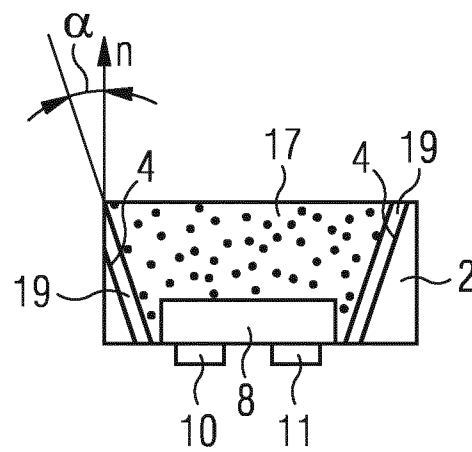


FIG 10

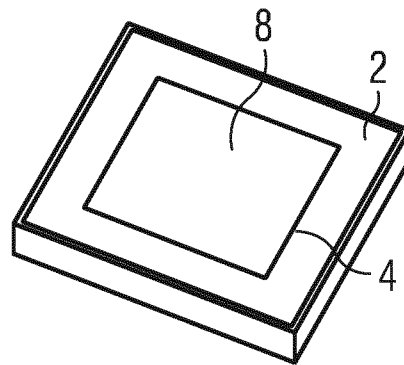


FIG 11

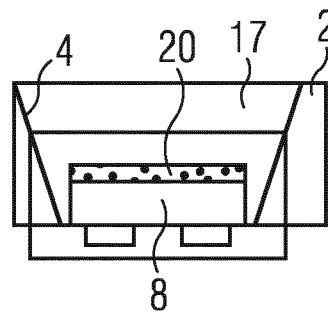


FIG 12

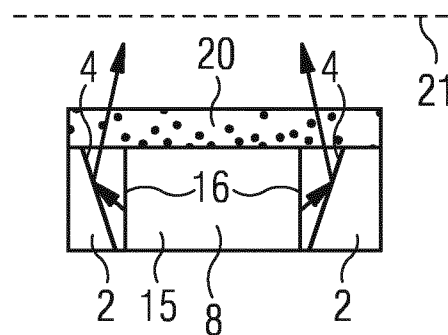


FIG 13

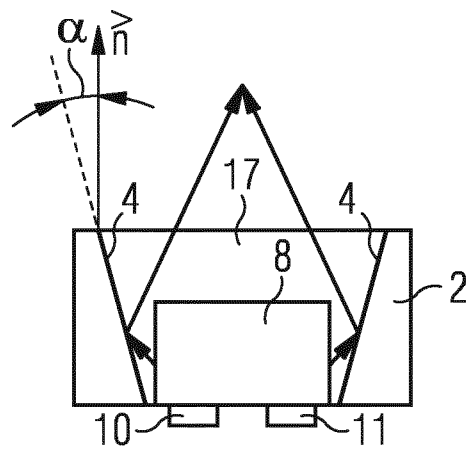


FIG 14

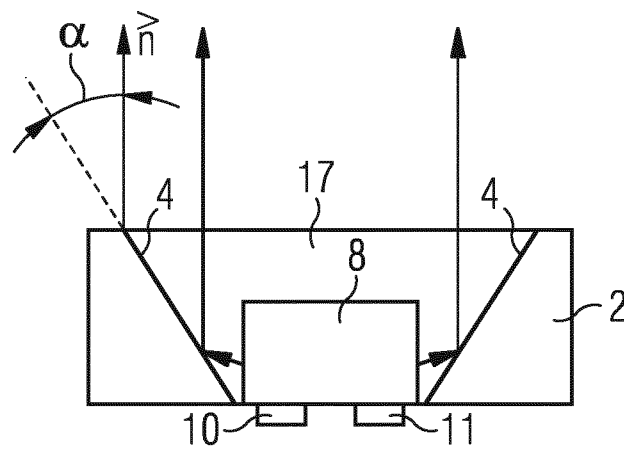


FIG 15

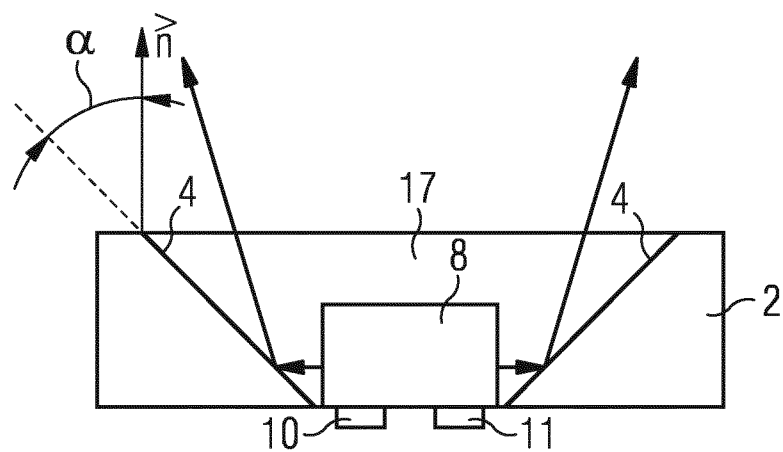


FIG 16

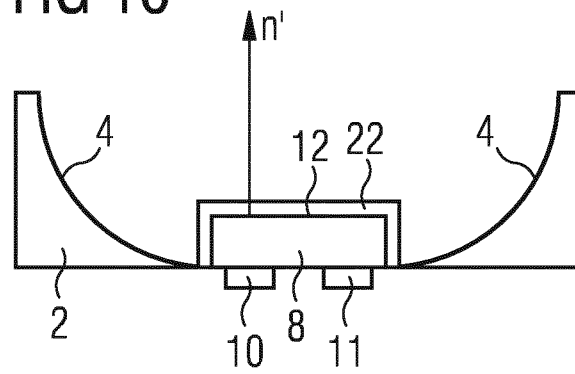
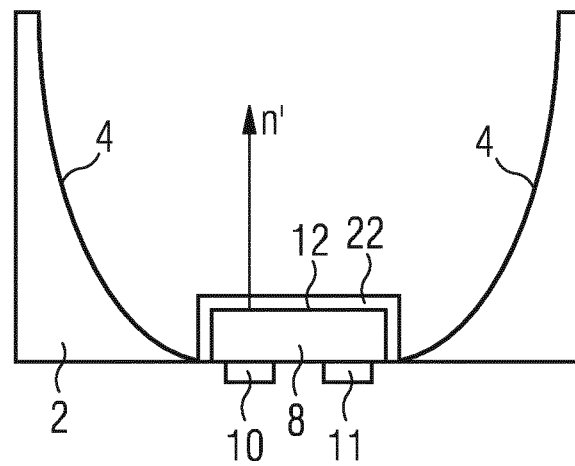


FIG 17



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/069906

A. CLASSIFICATION OF SUBJECT MATTER INV. H01L33/48 H01L33/54 H01L33/60 H01L33/00 ADD. H01L33/50		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) H01L		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2013/032842 A1 (PARK JONG KIL [KR] ET AL) 7 February 2013 (2013-02-07) paragraphs [0001] - [0034], [0038] - [0057], [0065] - [0093]; figures 1-4, 7-15 -----	1-13, 15-17 14
X A	US 2016/163932 A1 (BRANDL MARTIN [DE] ET AL) 9 June 2016 (2016-06-09) the whole document -----	1-3,6 7,12,14, 15,17
Y	WO 2015/036887 A1 (KONINKL PHILIPS NV [NL]) 19 March 2015 (2015-03-19) pages 1-10; figures 1-4 -----	14
A	US 2014/008683 A1 (PETERSEN KIRSTIN [DE] ET AL) 9 January 2014 (2014-01-09) paragraphs [0001] - [0076], [0096] - [0100]; figures 3A-3D -----	5
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
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Date of the actual completion of the international search 28 February 2017		Date of mailing of the international search report 08/03/2017
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Saynova, Desislava

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2016/069906

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2013032842 A1	07-02-2013	DE 102012213581 A1 KR 101219106 B1 US 2013032842 A1	07-02-2013 11-01-2013 07-02-2013
US 2016163932 A1	09-06-2016	CN 105340087 A DE 102013212928 A1 JP 6063610 B2 JP 2016523455 A KR 20160029030 A US 2016163932 A1 WO 2015001037 A1	17-02-2016 08-01-2015 18-01-2017 08-08-2016 14-03-2016 09-06-2016 08-01-2015
WO 2015036887 A1	19-03-2015	CN 105706237 A EP 3044809 A1 JP 2016536804 A KR 20160055880 A US 2016240755 A1 WO 2015036887 A1	22-06-2016 20-07-2016 24-11-2016 18-05-2016 18-08-2016 19-03-2015
US 2014008683 A1	09-01-2014	CN 103238224 A DE 102010053362 A1 EP 2647062 A1 KR 20130081321 A TW 201230386 A US 2014008683 A1 WO 2012072471 A1	07-08-2013 06-06-2012 09-10-2013 16-07-2013 16-07-2012 09-01-2014 07-06-2012