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DESCRIPTION

The present invention relates to the field of the fabrication of electronic components, especially components of the type having a semiconductor crystal connected to two metal tabs forming the connection leads, and the subject of the invention is a frame for the fabrication of such components, a fabrication process employing such a frame and components obtained by this process and by means, especially, of this frame.

Currently, there are mainly three techniques for fabricating electronic components of the aforementioned type, the characteristics of which techniques are described hereinbelow.

The first fabrication technique employs a precut metal tape (or frame) comprising two continuous structuring side bands and tabs which extend between the said bands and arranged in pairs, in which each component of each pair extends from one structuring side band towards the opposite structuring band, the tabs of each pair facing each other.

The said frame is moved longitudinally in an indexed manner so as to bring each pair of tabs level with each of the fabrication stations.

The semiconductor crystal C is fixed on the end of one of the tabs L1 and a separate connecting piece P is added and fixed by bonding in order to provide the electrical connection between the crystal C and the other tab L2 (Figure 1).

The protective package B is then added by moulding, and the tabs are cut off and the connection leads configured by forming.

However, this fabrication technique ends up with three internal connection points, greatly reducing the reliability of the component, and requires complex mounting equipment and slow production rates, resulting in high capital investment and high maintenance costs.

In addition, holding the tabs/crystal/connecting piece assembly in place before solidification of the

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bonding material is an operation of paramount importance for the quality of the final component, but this is always critical and difficult to be able to control reliably.

Furthermore, the low degree of precision of the mounting operation limits or even prevents this technique from being applied for the production of components of the "planar" type or having a crystal provided with a bump allowing prior mechanical orientation.

The second known fabrication technique, using a frame identical to that employed in the first aforementioned technique, consists in fixing a semiconductor crystal C on the end of one of the tabs L1 of a pair of tabs L1, L2, then in making a connection by means of a wire F of precious metal between the said crystal C and the other tab L2, next in protecting the said connecting wire F by spraying a polymerizable powder M and finally in adding the protective package B by moulding, in cutting off the tabs L1, L2 and in configuring the connection leads (Figure 2).

Nevertheless, this second fabrication technique requires expensive raw materials, also ends up with three connection points and allows production only of relatively low power components because of the limitation in the permissible cross-section of the connection wires.

In addition, this technique requires expensive equipment, only moderate production rates and sophisticated techniques requiring highly qualified maintenance personnel.

Furthermore, putting the protective layer of polymerizable powder M in place is a tricky and critical operation, on which the quality of the final component depends directly, which operation runs the risk, by spraying powder outside the region to be protected, of damaging the mould used for moulding the package E.

The third fabrication technique consists in making the junctions of the components by fastening together, with interposition of semiconductor crystals C, the ends of tabs L1 and L2 cut off from two

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independent frame portions arranged in such a way that the said ends of the tabs L1 and L2 overlap in pairs, and then in moulding the package B and forming the connection leads.

This third technique also has many drawbacks.

Thus, it does not allow continuous fabrication, the frame portions, of different geometries, necessarily being short and not enabling them to be wound up into rolls.

This assembly, using segments of limited lengths, requires, on the one hand, magazine-type-stacking and storage devices and specific tools, excluding any flexibility, and limits, on the other hand, the number of components assembled simultaneously, resulting in very low production rates.

Moreover, the assembly of many separate pieces, in the form of detached segments, reduces the precision of the mounting operation and makes the operation of overmoulding the package very random.

With a view to trying to alleviate the aforementioned drawbacks, a process has been proposed, for example by document JP-A-62,035,549, for fabricating semiconductor-crystal electronic components in which the two metal tabs forming, for each component, on the one hand, the pieces for holding the crystal and for internally connecting it and, on the other hand, the external connection leads of the component are cut out from the same frame.

This cutting-out is such that the said tabs are arranged in pairs, in which each component extends from a continuous structuring side band towards the opposite structuring band carrying the other tab, with provision of portions opposite each other, for the components of each pair, and with provision of a longitudinal shift between them, each pair of tabs, of different lengths, being separated from the adjacent pair by transverse tabs connecting the two continuous structuring side bands.

The fabrication process described in this document consists, after placing and fastening the

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semiconductor crystal at the free end of the shorter tab, in diagonally folding the end portion of the longer tab at an angle such that its free end is in contact with the crystal, the junction region subsequently being encapsulated in a mass of insulating synthetic material.

However, this known fabrication process ends up with components whose external connection leads are not in alignment with each other and whose package, for a given power, has a width which is increased because of the side-by-side arrangement of the two metal tabs in each component, which leads to an increase in the overall size of each component and a non-standard arrangement of the said leads, possibly resulting in it not being able to be used on standard circuits or in circuit-fabrication machines.

Furthermore, it is difficult to achieve, reproducibly and at high production rates, great precision in the diagonal folding carried out and optimum contact conditions between the folded end and the semiconductor crystal, therefore resulting in a significant amount of scrap during conformity tests.

With a view to trying to alleviate the aforementioned drawbacks, it has been proposed, especially in document EP-A-0,351,749, to employ a frame in which the tabs are also grouped together in pairs, in which each component extends from one continuous structural side band towards the opposite structural band carrying the other tab, with provision of facing structurally bent portions for each pair of tabs and of a longitudinal shift between the latter.

These two side bands are connected by inclined transverse tabs separating the various pairs from each other and connected to the said side bands by narrower parts.

The fabrication process consists especially, after depositing and fixing a semiconductor crystal on the downwardly folded free end of one of the two tabs, in simultaneously performing two movements of the two side bands relative to each other, one movement (in a

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direction normal to the plane of the frame) of which brings the tabs carrying the semiconductor crystals into a separate parallel plane, lying below the plane comprising the tabs which are not provided with crystals and having upwardly folded ends, and the other movement (in the longitudinal direction of the frame) of which aligns the two tabs of each pair.

Next, the first movement is reversed and the two tabs of each pair are again in the same plane, the crystal being pinched between the overlapping folded ends of the said tabs.

Next, the package is moulded and the usual conformity tests carried out.

Nevertheless, this fabrication process also has a number of drawbacks.

Thus, the structural side bands must each have perforations for index driving, and therefore an increased width of material, as well as mechanical properties sufficient for carrying out the two aforementioned relative movements, which thus results in a surplus of material which is not used within the initial frame.

In addition, in the case of continuous fabrication by means of very long frames, stresses are necessarily generated at the limits of the frame portion subjected to the relative movements, possibly leading to torsions in the starting frame, to misalignments during assembly of the tabs of each pair and to stressing, for example in the form of pulling, on the junctions between tabs and crystal, just outside the region of relative movements.

Finally, the tabs/crystal junctions may be subjected to possible elastic return forces or to permanent-set forces which are consequent upon the two relative movements of the structural side bands and are liable to break these junctions, this happening right at the moulding of the protective package at least.

The object of the present invention is especially to alleviate all the aforementioned drawbacks.

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Another object of the invention is to ensure as long as possible that the components obtained are attached and held in place rigidly and reliably on the frame, especially after cutting off and forming the portions of the tab(s) intended to form the connection leads of the component, so as to allow the support tape carrying the finished and tested components to be wound up again in the form of a reel.

An additional object of the invention is to ensure precise reproducibility, at high production rates, of the operations of assembling the conductive parts of the component, to ensure reliability of the junctions between the connection leads and the semiconductor crystal and to provide a continuous fabrication process requiring only limited investment in terms of equipment and in machines, and resulting in reduced maintenance costs.

To this end, the subject of the present invention is a frame for the fabrication of semiconductor-crystal electronic components, which mainly consists of at least two structural longitudinal side bands connected to each other, at regular intervals, by transverse segments between which are formed pairs of coplanar tabs, each of which is produced as a single piece with one of the structural side bands and extends towards the other of the said structural side bands, without touching the other tab of the pair in question, characterized in that the tabs of each pair are substantially aligned with each other and in that, on the one hand, one of the tabs of each pair has a free end portion forming an accommodating support for the semiconductor crystal and in that, on the other hand, the other tab of each pair has, at its free end, a connecting frame portion which can be folded so as to come into contact with the semiconductor crystal and which lies essentially within the volume defined by the planes delimiting the longitudinal edges of the said tabs.

The subject of the invention is also a process for fabricating semiconductor-crystal electronic compo-

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nents, using a frame consisting of at least two structural longitudinal side bands connected to each other, at regular intervals, by transverse segments between which pairs of coplanar tabs are formed, each of which is produced as a single piece with one of the structural side bands and extends towards the other of the said structural side bands, without touching the other tab of the pair in question, characterized in that it essentially consists in providing a long frame as mentioned hereinabove and in moving it longitudinally in indexed steps during which at least the following operations are carried out, in succession, at each pair of tabs:

- placing the semiconductor crystal on a matched accommodating support located at the portion of the free end of the first tab;

- folding a frame portion, integral with the free end of the second tab, and connecting this frame portion to the semiconductor crystal;

- moulding a protective package around the region of the tabs/crystal junction;

- cutting off the two tabs and cutting and forming the external connection leads;

- measurement test(s) and ejection of the defective components.

Finally, the present invention also relates to electronic components obtained by means of the aforementioned fabrication process and by using a frame as described hereinabove.

The invention will be easier to understand by virtue of the description hereinbelow which relates to preferred embodiments given by way of non-limiting examples and explained with reference to the appended diagrammatic drawings, in which:

- Figure 4 is a plan view of part of a frame according to a first embodiment of the invention;

- Figure 5 is a view, in side elevation and in partial section, of an electronic component obtained using the frame shown in Figure 4;

- Figure 6 is a plan view of part of a frame

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according to a second embodiment of the invention;

- Figure 7 is a detailed view on a different scale of part of a tab and of its lateral extension, forming part of that part of the frame shown in Figure 6;

- Figure 8 is a view, in side elevation and in section along A-A, of the extension shown in Figure 7;

- Figure 9 is a plan view, on a different scale, of that part of the frame shown in Figure 6, after depositing the bonding material for fixing the semiconductor crystal;

- Figure 10 is a view similar to that in Figure 9, after putting the semiconductor crystal in place;

- Figure 11 is a view similar to that in Figure 10, after the first folding of the L-shaped lateral extension through 90° and Figure 11A is a view, on a different scale and in front elevation, of the detail Z in Figure 11;

- Figure 12 is a view similar to that in Figure 11, after complete folding of the L-shaped lateral extension, Figure 12A is a view, on a different scale and in perspective, of the detail Y in Figure 12, Figure 12B is a view in side elevation of the detail shown in Figure 12A and Figure 12C is a plan view of the detail shown in Figure 12A;

- Figure 13 is a view similar to that in Figure 12, after depositing the conductive fusible contact bonding material in the through hole in the distal contact portion of the extension forming the connection lead and Figure 13A is a view on a different scale, in front elevation and partially in section along B-B, of the detail X in Figure 13;

- Figure 14 is a view similar to that in Figure 13, after moulding of the protective packages and of the intercalary studs, and Figure 14A is a view in front elevation of that part of the frame shown in Figure 14;

- Figure 15 is a view similar to that in Figure 14, after removal, for example by ejection, of the intercalary studs;

- Figure 16 is a view similar to that in Figure

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15, after cutting off the tabs and cutting the external connection leads;

- Figure 17 is a view similar to that in Figure 16, after a first conformity check or test and ejection of defective components;

- Figure 18 is a view similar to that in Figure 17, after forming the external connection leads and Figures 18A and 18B illustrate different ways of forming the said leads;

- Figure 19 is a view similar to that in Figure 18, after marking the protective packages of the components, especially laser marking, pressure-pad marking or screen printing;

- Figure 20 is a view similar to that in Figure 19, after a second conformity check or test, especially carried out hot, and ejection of the defective components;

- Figure 21 is a perspective view of an electronic component obtained according to the second embodiment of the invention, showing, transparently, the internal elements arranged inside the protective package, and

- Figures 22A and 22B are views in elevation, on a different scale and in section, respectively in a longitudinal mid-plane and in a transverse plane indicated by C-C in Figure 22A, of the electronic component shown in Figure 21.

As shown in Figures 4 to 12 of the appended drawings, the frame 1 for the fabrication of semi-conductor-crystal 2' electronic components 2 mainly consists of at least two structural longitudinal side bands 3 and 3' connected together, at regular intervals, by transverse segments 4 between which are formed pairs of coplanar tabs 5, 5', each of which is made of a single piece with one of the structural side bands 3 or 3' and extends towards the other of the said structural side bands 3' or 3, without touching the other tab of the pair in question.

In accordance with the invention, the tabs 5 and

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5' of each pair are substantially aligned with each other, one of the tabs 5 of each pair having a free end portion 6 forming an accommodating support for the semiconductor crystal 2' and the other tab 5' of each pair having, at its free end 7, a connecting frame portion 8 which may be folded so as to come into contact with the semiconductor crystal 2' and essentially lying within the volume defined by the planes delimiting the longitudinal edges of the said tabs 5, 5'.

Thus, all the elements for electrical connection of the final electronic component 2 are incorporated into a single frame 1, thereby favouring precise assembly and allowing continuous production, and only two electrical junction points are defined in the said component 2.

In addition, since the tabs 5, 5' are mutually aligned and hence there is no lateral projecting part remaining after folding the connecting frame portion 8, it will be possible for the protective package 19 to have a smaller overall size, especially a smaller width.

According to a first particular embodiment of the invention, shown in Figures 4 and 5 of the appended drawings, the connecting frame portion 8, of elongate rectilinear shape, is cut out in the free end portion 7 of the corresponding tab 5', being integral with the latter via its end facing the other tab 5, the length of the said frame portion 8 being such that, after making two 90° folds in the latter, one of which is at its end integral with the corresponding tab 5', the free distal portion 9 of its end segment 10 comes into contact with the semiconductor crystal 2' fixed to the free end portion 6 of the other tab 5.

Advantageously, the two regions 21 and 21' of 90° folding of the connecting frame portion 8 are spaced apart by a distance equivalent to the height of the semiconductor crystal 2' increased, as the case may be, by the height of a domed projecting part 9" formed on the face 9' of the free distal portion 9 and coming into contact with the crystal 2'.

By virtue of this arrangement, the crystal 2' is

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mechanically held in place by the free distal portion 9, especially during the phase when the bonding material 2" fixing the said crystal 2' is solidifying, on the corresponding accommodating support 6 of the tab 5.

According to a second preferred embodiment of the invention, shown in Figures 6 to 13 of the appended drawings, the connecting frame portion 8 consists of a preformed lateral extension having a substantially L-shaped configuration and composed of an end segment 10 substantially parallel to the longitudinal axes of the tabs 5, 5' in question and an intermediate linking segment 11 which is substantially perpendicular to the said longitudinal axes of the tabs 5, 5' in question and is provided with a weakened region 12 of preferred folding, the said extension 8 forming a lead for connection to the semiconductor crystal 2' placed on the free end portion 6 of the other tab 5, after folding it at the said weakened region 12.

This weakened region 12 may be obtained by cutting two lateral notches or a circular or oblong orifice in the intermediate linking segment 11, these notches or this orifice being located close to the free end portion 6 of the corresponding tab 5'.

It should be noted that the two aforementioned alternative forms of the connecting frame portion 8 make it possible to use the frame 1 according to the invention for the production of electronic components according to the techniques of the prior art which were mentioned previously, namely that using a connection wire of precious metal and that using an added connection piece, either by not folding the connecting frame portion 8 in the first embodiment or by cutting off the lateral extension 8 in the second embodiment, preferably at the weakened region 12.

In accordance with one characteristic of the invention, shown more particularly in Figures 7, 8, 12A, 12B and 12C of the appended drawings, the end segment 10 of the extension 8 has two spaced-apart bends or folds 13 and 13' which have opposite orientations and are formed

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in such a way that that free distal portion 9 of the said end segment 10 intended to come into contact with the semiconductor crystal 2', where appropriate, via a possibly holed domed projecting part 9", and formed on that face 9' of the portion 9 facing the crystal 2' lies in a plane offset in a parallel fashion with respect to the plane containing that portion 10' of the said end segment 10 which is proximal to the intermediate linking segment 11 and which is located on the opposite side from the two folds 13 and 13'.

Providing a domed projecting part 9", or a part having a different projecting shape, added or produced by deforming the corresponding region of the free distal portion 9, allows precise definition of the area or point of contact with the upper face of the crystal 2', thereby substantially eliminating poor connections, especially in the case of crystals 2' having a "planar" structure in which the area of contact is small.

The domed projecting part 9" may be provided with one or more holes for a fusible conductive contact bonding material 20 to pass through.

According to a preferred alternative form of the invention, the free distal portion 9 of the end segment 10 is provided with a through hole 14 centred with respect to the area of contact 15 of the said portion 9 with the semiconductor crystal 2', after folding the connecting frame portion 8.

Advantageously, the through hole 14 emerges on that face 9' of the free distal portion 9, facing the semiconductor crystal 2' after folding, at a crater-shaped projecting structure 16, the annular wall 16' of which, delimiting the opening of the said hole 14, is proud of the surface of the said face 9' of the distal portion 9 facing the semiconductor crystal 2' after folding.

For the purpose of facilitating the deposition of the fusible conductive bonding material 20 and to avoid unintentional deposition of fusible conductive bonding material 20 outside the area of contact 15, the through

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hole 14 may emerge, at that face of the free distal portion 9 opposite the face 9' intended to be turned towards the semiconductor crystal 2', at the bottom of a recess 17 such as a circular cup seating, for example.

The above arrangements therefore make it possible to facilitate the deposition of bonding material 20, to absorb any excess bonding material 20 by capillary action and retention in the recess 17 and to guarantee an area of contact 15 which is precise and delimited in a well-defined and accurately and identically reproducible manner.

The crater-shaped projecting structure 16 and the recess 17 are formed by deformation of the circumferential annular region surrounding the through hole 14.

For the purpose of guaranteeing easy folding (using simple mechanical operations) and precise orientation of the end segment 10 of the extension 8 after folding, the weakened region 12 of preferred folding, formed in the intermediate linking segment 11, defines a line 12' of preferred folding which is parallel to the axes of the corresponding tabs 5, 5' and allows 180° folding of the said extension 8 until there is planar contact between the folding portion 11' of the intermediate linking segment 11 and the free end 7 of the corresponding tab 5'.

In accordance with one characteristic of the invention, shown in Figures 6 to 8 and 12B of the appended drawings, the distance d between the upper edge 16" of the annular wall 16' of the crater-shaped projecting structure 16 and that face of the folding portion 11' of the intermediate linking segment 11 which comes into contact with the free end 7 of the corresponding tab 5', after completely folding the lateral extension 8, is substantially identical to the height of the semiconductor crystal 2'.

Determining the aforementioned distance d by preforming the extension 8 and precisely limiting the folding of the said extension 8 by means of a surface stop makes it possible to result, in a reproducible,

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reliable and precise manner, in the crystal 2' being held in place by pinching between the free distal portion 9 of the tab 5' or its projecting part or structure 9" or 16 and the accommodating support 6 of the tab 5, guaranteeing that the said crystal 2' is mechanically prevented from moving, especially before the fixing and contacting conductive bonding material 20 has solidified and before the protective package 19 has been moulded.

In accordance with another characteristic of the invention, and as shown especially in Figures 6 and 14 to 20 of the appended drawings, the transverse segments 14 have foot-shaped extensions 18, the free end portions 18' of which project into the volume which surrounds the tabs 5, 5'/crystal 2' junction and which is occupied later by the mass of the protective package 19 added by moulding, thus making it possible to hold the electronic components 2 in place on the frame 1 and to retain them there, after cutting off the tabs 5 and 5'.

Advantageously, each transverse segment 4 comprises two foot-shaped extensions 18 spaced apart on each of its sides.

In order to make best use of the material of which the frame 1 is composed and to end up with a high density of tabs 5, 5' and therefore of components 2 per unit length, the transverse segments 4 each have a portion 4' of smaller width opposite the free ends of the tabs 5, 5', that region of the frame thus freed being used, at least partially, for the cutting-out of the folding lateral extension 8 forming the connection lead.

The subject of the present invention is also a process for fabricating semiconductor-crystal electronic components, using a frame 1 consisting of at least two structural longitudinal side bands 3 and 3' connected to each other, at regular intervals, by transverse segments between which pairs of coplanar tabs 5 and 5' are formed, each of which is produced as a single piece with one of the structural side bands and extends towards the other of the said structural side bands, without touching the other tab of the pair in question.

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As shown in Figures 4, 5, 6 and 9 to 20 of the appended drawings, the said process essentially consists in providing a long frame 1 as described hereinbelow and in moving it longitudinally in indexed steps during which at least the following operations are carried out, in succession, at each pair of tabs 5, 5':

- placing the semiconductor crystal 2' on a matched accommodating support 6 located at the portion of the free end of the first tab 5;

- folding a frame portion 8, integral with the free end 7 of the second tab 5', and connecting this frame portion to the semiconductor crystal 2';

- moulding a protective package 19 around the region of the tabs 5, 5'/crystal 2' junction;

- cutting off the two tabs 5 and 5' and cutting and forming the external connection leads;

- measurement test(s) and ejection of the defective components 2.

According to a first alternative form of the invention, shown in Figures 6 and 9 to 12 of the appended drawings, the frame portion 8 of the second tab 5' consists, before folding, of a lateral extension in the form of an L, connected by the end of the segment 11 forming the base of the L to the said second tab 5' and the segment 10 forming the other branch of the L, of which lateral extension extends parallel to the said tabs 5, 5', with a free distal portion 9 located opposite the accommodating support 6 of the first tab 5, but in a plane which is offset in a parallel fashion with respect to the plane containing the said tabs 5 and 5', the folding of the said extension 8 taking place, on the one hand, at a weakened region 12 of the segment 11 forming the base of the L and along a folding line 12' parallel to the longitudinal axes of the tabs 5 and 5' and being extended, on the other hand, until the folding part 11' of the said segment forming the base of the L comes into contact with the free end 7 of the second tab 5'.

The L-shaped extension 8 is folded by means of a first 90° folding movement at the weakened region 12,

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followed by a second 90° folding movement at this region, resulting in a folding part 11' of the segment 11 forming the base of the L being folded down completely against the surface of the free end 7 of the second tab 5', it being possible for this second folding movement to be divided into at least two partial folding movements (Figures 11 and 12).

According to a second alternative form of the invention, shown in Figures 4 and 5 of the appended drawings, the connecting frame portion 8, cut out in the free end portion 7 of the second tab 5' and having an elongate rectilinear shape, is folded firstly through 90° at its end integral with the said second tab 5' and a second time through 90° in the direction of the first tab 5, the two folding regions being spaced apart by a distance equivalent to the height of the semiconductor crystal 2' and the length of the said frame portion 8 being such that the free distal portion 9 is brought, after the folding operations, into contact with the semiconductor crystal 2'.

As shown in Figures 5, 13, 22A and 22B of the appended drawings, the connection of the semiconductor crystal 2' to the second tab 5' is brought about, after folding the frame portion 8, by mechanical contact with a projecting part 9" or 16 of the free distal portion 9 and by placing some conductive fusible bonding material between the latter and the crystal 2' or by injecting a conductive fusible bonding material 20 in a through hole 14 made in the free distal portion 9 and emerging on that face 9' of the latter which is facing the said crystal 2' at a domed projecting part or structure 9" or a crater-shaped projecting part or structure 16, which is in mechanical contact with the said crystal 2' after folding the connecting frame portion 8.

According to another characteristic of the invention, the substance forming the protective package 19 is also moulded around the free ends 18' of the foot-shaped extensions 18 which extend from and are integral with the transverse segments 14, the defective components

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2 being ejected by applying a pressure on these components which is sufficient to break the link between the package 19 and the foot-shaped extensions 18.

By virtue of this arrangement, the frame 1 may be unwound from a reel and, after producing and marking the electronic components 2 and checking and ejecting the defective components 2, the said frame 1 carrying the viable final components 2 held in place by the extensions 18 may be wound up again into a reel.

Furthermore, the electrical-type checks or tests may be carried out on components 2 which are completely isolated (connection leads in the air) and the two external connection leads may be formed while the components 2 are still held in place on the frame 1, which ensures that they are transferred uniformly, continuously and in large numbers, as well as ensuring that they are held in place in an oriented manner throughout all the operations of fabrication of the said components 2.

In addition, since the frame 1 serves as a support during all the fabrication operations, transfer onto equipment is greatly simplified or even eliminated.

The fabrication process according to the invention may consist, more precisely, of the following steps:

- unwinding and transferring, by index driving, a frame 1 as described previously, especially comprising pairs of tabs 5 and 5', the tabs 5' of which are provided with preformed lateral extensions 8 having weakened regions 12 of preferred folding (Figure 6);
- depositing a defined quantity of conductive bonding material 2" on the free end portion 6 of the tabs 5 (Figure 9);
- depositing a preoriented semiconductor crystal 2' (for example provided with a stop or with a domed surface at one of its functional faces) on the conductive bonding material 2" (Figure 10);
- folding the lateral extension 8 at the weakened region 12 through 90° (Figure 11);
- folding the lateral extension 8 through 180°,

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this folding being limited by the folding portion 11' of the intermediate linking segment 11 coming up against the surface stop on the free end 7 of the tab 5' (Figure 12);

- putting fusible conductive bonding material 20 in place at the area of extension 8/crystal 2' contact, for example by depositing it in a through hole 14 emerging at a projecting structure or part 9" or 16 of the free distal portion 9 of the extension 8 (Figures 13 and 13A);

- solidifying the bonding material 20;

- moulding the protective package 19 around the semiconductor junction and around the ends 18' of the extensions 18 emanating from the transverse segments 4, and moulding the intercalary studs 22 (Figures 14 and 14a);

- tinning those portions of the tabs 5 and 5' which are not included in the protective package 19;

- removing the intercalary studs 22 by ejecting them (Figure 15);

- cutting the connection leads and then cutting off the tabs 5 and 5' (Figure 16);

- testing, by electrical measurement, and ejecting components which are substandard;

- forming the connection leads (Figure 18);

- marking the components 2 remaining, with regard to the reference of the component and its polarity (Figure 19);

- hot behaviour testing and ejecting of the substandard components 2 (Figure 20);

- packaging the frame 1 with the viable components remaining, followed by reeling it up and then storing or dispatching it.

Among the advantages of the aforementioned process, mainly resulting from the particular features of the frame 1 as described hereinabove, mention may especially be made of the possibility of using this frame 1 for the fabrication of components using conventional techniques (by cutting the lateral extension 8 at its folding line), the possibility of using crystals 2' in loose form

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or using film, the absence of requiring prior protection of the connections before moulding the package, the production of the product (components) in the form of a continuous tape and with great flexibility, the easy storage and manipulation of the components and of the initial tape in the form of rolls, the possibility of using inexpensive mounting, transferring and sorting equipment, at high production rates, using conventional technologies, the maintenance of which equipment may be provided by conventionally trained technicians.

The subject of the present invention is also a semiconductor-crystal electronic component, obtained by means of the fabrication process as described hereinabove and using, especially, an abovementioned frame 1, and essentially composed of a protective package 19 surrounding the semiconductor junction region and of two metal tabs 5, 5' forming the external connection leads, one of which carries the semiconductor crystal 2', at its end located in the package 19, characterized in that the second tab 5' has, at its end located in the protective package 19, an extension 8 which is preformed, made as one piece with the said tab 5', and is folded by laterally folding it down so as to come into contact with the semiconductor crystal 2'.

Advantageously, the preformed extension 8 has a general shape of an L with an intermediate linking segment 11 folded on itself and a doubly bent end segment 10, the distal end portion 9 of which is in contact with the upper face of the semiconductor crystal 2', this possibly having a domed shape, by means of a domed or projecting part 9" or of a crater-shaped projecting structure 16 forming the opening of a through hole 14 accommodating a conductive contact bonding material 20 which provides electrical connection and, at least partially, mechanical integrity of the said distal end portion with the semiconductor crystal 2'.

Finally, the subject of the present invention is, in addition, a semiconductor-crystal electronic component 1, obtained by means of the fabrication process described

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hereinabove, as an alternative form, and using, especially, a frame 1 as described previously, and comprising a protective package 19 surrounding the junction region and two metal tabs 5 and 5' forming the external connection leads, one of which carries the semiconductor crystal 2', at its end located in the package 19, characterized in that the second tab 5' has, at its end located in the package 19, a frame portion 8, of elongate shape, which is cut out in the said tab 5' and is shaped by two separate 90° folding operations into a connection lead in contact with the semiconductor crystal 2' at a distal end portion 9 (Figures 4 and 5).

As shown in Figure 5, the distance d between the two 90° folding regions 21 and 21' is substantially equivalent to the height of the semiconductor crystal 2', the distal end portion 9 being in contact with the upper face of the semiconductor crystal 2' by means of a domed projecting part of a crater-shaped projecting structure 16 forming the opening of a through hole 14 accommodating a conductive contact bonding material 20 which provides electrical connection and, at least partially, mechanical integrity of the said distal end portion 9 with the semiconductor crystal 2'.

Of course, the invention is not limited to the embodiments described and shown in the appended drawings. Modifications remain possible, especially from the point of view of the construction of the various elements or by substitution of technical equivalents, without thereby departing from the protective scope of the invention.

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CLAIMS

1. Frame for the fabrication of semiconductor-crystal electronic components, which mainly consists of at least two structural longitudinal side bands connected to each other, at regular intervals, by transverse segments between which are formed pairs of coplanar tabs, each of which is produced as a single piece with one of the structural side bands and extends towards the other of the said structural side bands, without touching the other tab of the pair in question, characterized in that the tabs (5 and 5′) of each pair are substantially aligned with each other and in that, on the one hand, one of the tabs (5) of each pair has a free end portion (6) forming an accommodating support for the semiconductor crystal (2′) and in that, on the other hand, the other tab (5′) of each pair has, at its free end (7), a connecting frame portion (8) which can be folded so as to come into contact with the semiconductor crystal (2′) and which lies essentially within the volume defined by the planes delimiting the longitudinal edges of the said tabs (5, 5′).

2. Frame according to Claim 1, characterized in that the connecting frame portion (8), of elongate rectilinear shape, is cut out in the free end portion (7) of the corresponding tab (5′), being integral with the latter via its end facing the other tab (5), the length of the said frame portion (8) being such that, after making two 90° folds in the latter, one of which is at its end integral with the corresponding tab (5′), the free distal portion (9) of its end segment (10) comes into contact with the semiconductor crystal (2′) fixed to the free end portion (6) of the other tab (5).

3. Frame according to Claim 2, characterized in that the two regions (21 and 21′) of 90° folding of the connecting frame portion (8) are spaced apart by a distance equivalent to the height of the semiconductor crystal (2′) increased, as the case may be, by the height of a domed projecting part (9″) formed on the face (9′)



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of the free distal portion (9) and coming into contact with the crystal (2').

4. Frame according to Claim 1, characterized in that the connecting frame portion (8) consists of a preformed lateral extension having a substantially L-shaped configuration and composed of an end segment (10) substantially parallel to the longitudinal axes of the tabs (5, 5') in question and an intermediate linking segment (11) which is substantially perpendicular to the said longitudinal axes of the tabs (5, 5') in question and is provided with a weakened region (12) of preferred folding, the said extension (8) forming a lead for connection to the semiconductor crystal (2') placed on the free end portion (6) of the other tab (5), after folding it at the said weakened region (12).

5. Frame according to Claim 4, characterized in that the end segment (10) of the extension (8) has two spaced-apart bends or folds (13 and 13') which have opposite orientations and are formed in such a way that that free distal portion (9) of the said end segment (10) intended to come into contact with the semiconductor crystal (2'), where appropriate, via a possibly holed domed projecting part (9"), and formed on that face (9') of the portion (9) facing the crystal (2') lies in a plane offset in a parallel fashion with respect to the plane containing that portion (10') of the said end segment (10) which is proximal to the intermediate linking segment (11) and which is located on the opposite side from the two folds (13 and 13').

6. Frame according to any one of Claims 2, 3 and 5, characterized in that the free distal portion (9) of the end segment (10) is provided with a through hole (14) centred with respect to the area of contact (15) of the said portion (9) with the semiconductor crystal (2'), after folding the connecting frame portion (8).

7. Frame according to Claim 6, characterized in that the through hole (14) emerges on that face (9') of the free distal portion (9), facing the semiconductor crystal (2') after folding, at a crater-shaped projecting

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structure (16), the annular wall (16') of which, delimiting the opening of the said hole (14), is proud of the surface of the said face (9') of the distal portion (9) facing the semiconductor crystal (2') after folding.

8. Frame according to either of Claims 6 and 7, characterized in that the through hole (14) emerges, at that face of the free distal portion (9) opposite the face (9') intended to be turned towards the semiconductor crystal (2'), at the bottom of a recess (17) such as a circular cup seating, for example.

9. Frame according to Claims 7 and 8, characterized in that the crater-shaped projecting structure (16) and the recess (17) are formed by deformation of the circumferential annular region surrounding the through hole (14).

10. Frame according to any one of Claims 4 to 9, characterized in that the weakened region (12) of preferred folding, formed in the intermediate linking segment (11), defines a line (12') of preferred folding which is parallel to the axes of the corresponding tabs (5, 5') and allows 180° folding of the said extension (8) until there is planar contact between the folding portion (11') of the intermediate linking segment (11) and the free end (7) of the corresponding tab (5').

11. Frame according to any one of Claims 7 to 10, characterized in that the distance (d) between the upper edge (16") of the annular wall (16') of the crater-shaped projecting structure (16) and that face of the folding portion (11') of the intermediate linking segment (11) which comes into contact with the free end (7) of the corresponding tab (5'), after completely folding the lateral extension (8), is substantially identical to the height of the semiconductor crystal (2').

12. Frame according to any one of Claims 1 to 11, characterized in that the transverse segments (4) have foot-shaped extensions (18), the free end portions (18') of which project into the volume which surrounds the tabs (5, 5')/crystal (2') junction and which is occupied later by the mass of the protective package (19) added by

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moulding.

13. Frame according to Claim 12, characterized in that each transverse segment (4) comprises two foot-shaped extensions (18) spaced apart on each of its sides.

14. Frame according to any one of Claims 4 to 13, characterized in that the transverse segments (4) each have a portion (4') of smaller width opposite the free ends of the tabs (5, 5'), that region of the frame thus freed being used, at least partially, for the cutting-out of the folding lateral extension (8) forming the connection lead.

15. Process for fabricating semiconductor-crystal electronic components, using a frame consisting of at least two structural longitudinal side bands connected to each other, at regular intervals, by transverse segments between which pairs of coplanar tabs are formed, each of which is produced as a single piece with one of the structural side bands and extends towards the other of the said structural side bands, without touching the other tab of the pair in question, characterized in that it essentially consists in providing a long frame according to any one of Claims 1 to 14 and in moving it longitudinally in indexed steps during which at least the following operations are carried out, in succession, at each pair of tabs (5, 5'):

- placing the semiconductor crystal (2') on a matched accommodating support (6) located at the portion of the free end of the first tab (5);
- folding a frame portion (8), integral with the free end (7) of the second tab (5'), and connecting this frame portion to the semiconductor crystal (2');
- moulding a protective package (19) around the region of the tabs (5, 5')/crystal (2') junction;
- cutting off the two tabs (5 and 5') and cutting and forming the external connection leads;
- measurement test(s) and ejection of the defective components (2).

16. Process according to Claim 15, characterized in that the frame portion (8) of the second tab (5')

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consists, before folding, of a lateral extension in the form of an L, connected by the end of the segment (11) forming the base of the L to the said second tab (5') and the segment (10) forming the other branch of the L, of which lateral extension extends parallel to the said tabs (5, 5'), with a free distal portion (9) located opposite the accommodating support (6) of the first tab (5), but in a plane which is offset in a parallel fashion with respect to the plane containing the said tabs (5 and 5'), the folding of the said extension (8) taking place, on the one hand, at a weakened region (12) of the segment (11) forming the base of the L and along a folding line (12') parallel to the longitudinal axes of the tabs (5 and 5') and being extended, on the other hand, until the folding part (11') of the said segment forming the base of the L comes into contact with the free end (7) of the second tab (5').

17. Fabrication process according to Claim 16, characterized in that the L-shaped extension (8) is folded by means of a first 90° folding movement at the weakened region (12), followed by a second 90° folding movement at this region, resulting in a folding part (11') of the segment (11) forming the base of the L being folded down completely against the surface of the free end (7) of the second tab (5'), it being possible for this second folding movement to be divided into at least two partial folding movements.

18. Fabrication process according to Claim 15, characterized in that the connecting frame portion (8), cut out in the free end portion (7) of the second tab (5') and having an elongate rectilinear shape, is folded firstly through 90° at its end integral with the said second tab (5') and a second time through 90° in the direction of the first tab (5), the two folding regions being spaced apart by a distance equivalent to the height of the semiconductor crystal (2') and the length of the said frame portion (8) being such that the free distal portion (9) is brought, after the folding operations, into contact with the semiconductor crystal (2').

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19. Fabrication process according to any one of Claims 16 to 18, characterized in that the connection of the semiconductor crystal (2') to the second tab (5') is brought about, after folding the frame portion (8), by mechanical contact with a projecting part (9") or (16) of the free distal portion (9) and by placing some conductive fusible bonding material between the latter and the crystal (2') or by injecting a conductive fusible bonding material (20) in a through hole (14) made in the free distal portion (9) and emerging on that face (9') of the latter which is facing the said crystal (2') at a domed projecting part or structure (9") or a crater-shaped projecting part or structure (16), which is in mechanical contact with the said crystal (2') after folding the connecting frame portion (8).

20. Fabrication process according to any one of Claims 15 to 19, characterized in that the substance forming the protective package (19) is also moulded around the free ends (18') of the foot-shaped extensions (18) which extend from and are integral with the transverse segments (14), the defective components (2) being ejected by applying a pressure on these components which is sufficient to break the link between the package (19) and the foot-shaped extensions (18).

21. Fabrication process according to any one of Claims 15 to 20, characterized in that the frame (1) is unwound from a reel and in that, after producing and marking the electronic components (2) and checking and ejecting the defective components (2), the said frame (1) carrying the viable final components (2) held in place by the extensions (18) is wound up again into a reel.

22. Semiconductor-crystal electronic component obtained by means of the fabrication process according to any one of Claims 15 to 17 and 19 to 21 and using, especially, a frame according t any one of Claims 1 and 4 to 14, the frame being essentially composed of a protective package surrounding the semiconductor junction region and of two metal tabs forming the external connection leads, one of which carries the semiconductor

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crystal (2'), at its end located in the package, characterized in that the second tab (5') has, at its end located in the protective package (19), an extension (8) which is preformed, made as one piece with the said tab (5'), and is folded by laterally folding it down so as to come into contact with the semiconductor crystal (2').

23. Electronic component according to Claim 22, characterized in that the preformed extension (8) has a general shape of an L with an intermediate linking segment (11) folded on itself and a doubly bent end segment (10), the distal end portion (9) of which is in contact with the upper face of the semiconductor crystal (2'), this possibly having a domed shape, by means of a domed or projecting part (9") or of a crater-shaped projecting structure (16) forming the opening of a through hole (14) accommodating a conductive contact bonding material (20) which provides electrical connection and, at least partially, mechanical integrity of the said distal end portion with the semiconductor crystal (2').

24. Semiconductor-crystal electronic component obtained by means of the fabrication process according to any one of Claims 15 and 18 to 21 and using, especially, a frame according to any one of Claims 1 to 3, 6 to 9 and 11 to 13, and comprising a protective package surrounding the junction region and two metal tabs forming the external connection leads, one of which carries the semiconductor crystal, at its end located in the package, characterized in that the second tab (5') has, at its end located in the package (19), a frame portion (8), of elongate shape, which is cut out in the said tab (5') and is shaped by two separate 90° folding operations into a connection lead in contact with the semiconductor crystal (2') at a distal end portion (9).

25. Electronic component according to Claim 24, characterized in that the distance (d) between the two 90° folding regions (21 and 21') is substantially equivalent to the height of the semiconductor crystal (2'), the distal end portion (9) being in contact with

the upper face of the semiconductor crystal (2') by means of a domed projecting part of a crater-shaped projecting structure (16) forming the opening of a through hole (14) accommodating a conductive contact bonding material (20) which provides electrical connection and, at least partially, mechanical integrity of the said distal end portion (9) with the semiconductor crystal (2').

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