Description

Leadframe and component with a leadframe

The invention relates to a leadframe of a conductive material, having a central region to accommodate a chip, and a plurality of connecting fingers which extend at least from one side in the direction of the central region, a contact region being provided adjacent to the central region on at least some of the connecting fingers. The invention relates further to a component comprising a chip, a leadframe of a conductive material, having a central region and connecting fingers, and a housing of a molding compound, the chip having contact pads on its upper side which are connected electrically to the connecting fingers, and the housing enclosing the chip and regions of the connecting fingers.

Components of the abovementioned type are also called SMD (Surface Mounted Device) components. There is a large number of different housing designs, which are of different sizes and have a different number of connecting fingers. SMD components permit standardized production and automatic population of printed circuit boards to which they are applied.

A typical structure of an SMD component is described below. A chip is firstly connected to a system carrier. The system carrier is frequently designed as a leadframe and has a central region to accommodate a chip and a plurality of connecting fingers, which extend from at least one side in the direction of the central region. In some leadframes, the central region is designed as an island-like chip carrier. The chip is fitted to this chip carrier, for example by

adhesive bonding, soldering or alloying, and connected firmly thereto. In another variant, the central region is formed by the connecting fingers themselves. In this case, the connecting fingers extend from at least two opposite sides in the direction of the central region. The chip is fixed to the leadframe in such a way that an adhesive layer, generally in the form of an adhesive strip, is applied to the active main side of the chip. Regions of the connecting fingers are brought into contact with the adhesive, so that retention of the chip is achieved. An arrangement of this type is also designated LOC (Lead On Chip). Its identifying feature is that the connecting fingers partly overlap the chip face, by which means mechanical fixing of the chip is achieved. After the chip has been connected to the leadframe, its individual contact pads are connected to contact regions on the connecting fingers. The electrical connection is produced, for example, by bonding wires. The chip and the connecting fingers of the connecting frame are then encapsulated in such a way that the chip is surrounded completely by a molding compound and the connecting fingers project to some extent out of the housing. The housing normally consists of a curable plastic molding compound, which is processed at about 175 degrees C. The regions of the leadframe which are not needed are then removed by punching.

During the production of the component, during the fitting of the latter to a printed circuit board and during operation, both are subjected to high loadings. During production, the component is subjected to mechanical loadings as a result of bending the regions of the connecting fingers which are located outside the housing, or by punching out the parts of the leadframe which are not

needed. When the component is soldered onto a printed circuit board, it is subjected to temperatures in the range between 220° and 240°C, so that thermal-mechanical stresses act on said component. During the operation of the component itself, high temperatures likewise arise, which cause thermal stresses. These stresses arise as a result of the fact that the materials of the leadframe, of the housing and of the chip itself have different coefficients of thermal expansion. Because of this, shear stresses arise in the interior of the component. These shear stresses can cause delamination at the points at which leadframe material meets housing material. Furthermore, cracks can occur in the housing and in the chip. As a result of penetrating moisture, the component can then be impaired in terms of its ability to function. Cracks in the chip can lead to functional failure.

During the design of the components, attempts are therefore made to achieve neutral stress states as far as possible during manufacture, by means of appropriate material selection, by means of the design of the leadframe and by means of the process configuration. In particular, the configuration of the leadframe has a decisive influence on the ruggedness of the component with regard to process-induced stresses or forces on the housing, which are viewed as a latent cause for housing fractures which continually occur.

In order to avoid difficulties of this type, "downsets", as they are known, are often provided. This design is used almost exclusively in leadframes with a chip island. In this case, the island-like chip carrier is offset upward or downward with respect to the connecting fingers. After the

chip has been fitted and the housing has been provided, the chip is surrounded on its upper and lower side by a housing cover of equal thickness. By this means, it is possible to reduce bending of the housing which is caused by different coefficients of expansion of the materials used (chip, plastic molding compound). The downset is provided regularly only for small chips.

Otherwise, the focus of the configuration of the leadframes lies in their electrical performance. The leadframes, that is to say in particular the shape of the connecting fingers, are optimized to short signal propagation paths and to a connection configuration in relation to the chip which is optimum for wire bonding. Leadframes which are provided for use in the aforementioned LOC housings are likewise designed only with regard to their electrical performance.

It is therefore an object of the present invention to provide a leadframe which imparts a higher mechanical stability to a component, so that damage, in particular as a result of delamination, is largely avoided.

This object is achieved by a leadframe having the features of claim 1. A component having the leadframe according to the invention is reproduced in patent claim 9. Advantageous refinements in each case emerge from the dependent claims.

According to the invention, provision is made to configure the course of the connecting fingers in such a way that the sectional face in any imaginary cross section at right angles to the main face of the leadframe has leadframe material, whereby the relationship between leadframe material and the other material occurring in the

semiconductor component is approximately the same. If the leadframe according to the invention is arranged in a semiconductor component, then the course of the connecting fingers in the interior of the housing is such that the sectional face in any arbitrary imaginary cross section at right angles to the main face of the semiconductor component has leadframe material, whereby the relationship between leadframe material and the other material occurring in the semiconductor component is approximately the same. As many sectional faces as desired can be imagined in every leadframe and in every semiconductor component. Irrespective of how a section is made through the leadframe or the semiconductor component, provision is made for leadframe material to be arranged in the sectional face. The aim in this case is to create similar conditions at all the conceivable cross sections.

The invention is based on the finding that the leadframe plays the critical part in the ruggedness of the semiconductor component with respect to mechanical or thermal stresses. In conventional components, in particular in components of LOC design, there are sectional faces which do not have any kind of leadframe material. These sectional faces, also referred to as fracture lines or stress lines, constitute a potential weak point in the housing, at which cracks often occur in the housing. On the basis that these fracture lines or cross sections at which the cracks in the housing arise do not have any leadframe material, provision is now made to configure the leadframe, in particular the connecting fingers, in such a way that each sectional face going through the leadframe or the semiconductor component has at least a low proportion of leadframe material. The ruggedness of the leadframe or of the semiconductor

component becomes greater the more leadframe material is provided in relation to the other materials - housing or chip. It is particularly advantageous if the relationship between leadframe material and the other materials occurring in the semiconductor component is approximately the same, since in this way potential weak points in the housing are avoided.

By means of the configuration according to the invention of the leadframe, account is also taken of the criteria of electrical performance and the connection configuration with regard to subsequent wire bonding. In this case, the precise arrangement of the connecting fingers can be determined only by means of an optimization procedure. However, a significant feature is that the housing is reinforced substantially in terms of the transverse stability, critical for the action of forces, with regard to fracture load or crack susceptibility.

In a preferred refinement of the invention provision is made to arrange the connecting fingers in the leadframe in such a way that they cross at least one of the sectional faces. If the fracture lines in the components known from the prior art occur predominantly in the region of the axes of symmetry of the component, then the connecting fingers are consequently arranged in such a way that at least those connecting fingers which are adjacent to the axis of symmetry of the leadframe cross the axis of symmetry. In principle, it is sufficient for only one connecting finger to cross one of the sectional faces. If the design of the leadframe permits, it is of course also possible for a plurality of connecting fingers, preferably adjacent connecting fingers, to cross a sectional face.

In a further advantageous refinement of the invention, provision is made to provide the connecting fingers with material reinforcements, so that the material reinforcements cross at least one of the sectional faces. In this case, a material reinforcement can signify an enlargement of the width (in the plan view of the leadframe) of individual connecting fingers. However, material reinforcement also includes at least individual connecting fingers being changed in their thickness (as viewed in the cross section of the leadframe). Which of the connecting fingers is provided with material reinforcements and how many of the connecting fingers are provided with such material reinforcements is an optimization process. The latter is carried out while taking account of the condition that, at all the conceivable cross sections, the relationship of leadframe material to the other materials of the semiconductor component is approximately the same. The material reinforcements of the connecting fingers are preferably arranged at the points at which they cross an axis of symmetry of the leadframe or semiconductor component.

Although the material reinforcements can in principle have any conceivable shape, it has proven to be advantageous to design the reinforcements in the shape of an anchor or a paddle.

Since the abovementioned material reinforcements of at least individual connecting fingers also have effects on the electrical properties (for example parasitic capacitances, signal coupling), it is advantageous if the connecting fingers which have material reinforcements are not intended to perform an electrical function. If such connecting

fingers have to perform an electrical function, care should be taken to design these connecting fingers as short as possible, in accordance with the electrical requirements.

Furthermore, it is advantageous if connecting fingers with material reinforcements and connecting fingers without material reinforcements are arranged alternately. This configuration also takes into account the signal coupling between connecting fingers placed beside one another.

The invention will be explained in more detail using the following drawings, in which:

Figure 1 shows an exemplary embodiment of a leadframe according to the invention in plan view,

Figures 2a to 2c show various configuration variants of a connecting finger,

Figure 3 shows a leadframe known from the prior art in plan view,

Figures 4 to 6 show various cross sections of the leadframe illustrated in figure 3.

Figure 1 shows an exemplary embodiment of a leadframe 10 according to the invention. The leadframe 10 has a large number of connecting fingers 12 which, for example, extend from two opposite sides in the direction of a central region 14. The present leadframe 10 is configured without an island-like chip carrier, that is to say is provided for components using LOC technology. The individual connecting fingers 12 are interconnected by a sealing web 16, which is

punched away after the fixing of a chip (which cannot be seen from the figure) and the provision of a housing (which likewise cannot be seen). Likewise, the connecting webs 20 at the respective outer edge of the leadframe are punched away. In the connecting webs 20 there are transport holes 18 of elongate design, using which the leadframe, usually present in strip form, can be transported in a processing tool. At the regions identified by the designation 40, an adhesive in the form of a double-sided adhesive tape is applied, with which the chip can be fixed to the leadframe 10. Depending on the size of the chip, only the adhesive areas 40 placed in the central region may be provided.

The leadframe 10 illustrated in figure 1 is distinguished by the fact that leadframe material is placed in any desired sectional face which runs at right angles to the main face of the leadframe and in the direction of the course of the connecting fingers. As an example, since in practice it is the most critical sectional face, the designation 36 shows a fracture line which is located on the axis of symmetry of the leadframe 10. As can be seen well from figure 1, the connecting fingers identified by the designation 12' cross the sectional face 36. The leadframe material of the connecting fingers 12' present in the sectional face leads to strengthening of the component.

In the leadframes known from the prior art, the sectional face in the region of the axis of symmetry of the leadframe or a semiconductor component generally has no leadframe material. A leadframe of this type, known from the prior art, is illustrated in figure 3. From this figure, the arrangement of the chip 26 in the central region 14 of the leadframe can also be seen. The chip 26 is connected by its

upper side to the connecting fingers 12 of the leadframe 10. In the mid-axis of the chip 26 there is a large number of contact pads 30, which are in each case connected via a bonding wire 38 to contact areas 34 at the ends of the connecting fingers 12.

As an example, three sectional faces 36 (also designated a fracture line) are shown in figure 3, of which in each case the cross section can be seen in figures 4 to 6. The cross-sectional illustration in figure 4 represents an ideal sectional face with regard to fracture strength. In the cross section of figure 4, the connecting fingers 12 each run without interruption, as a result of which, overall, a sectional face which can be loaded very highly mechanically is represented.

Capable of being loaded somewhat less is the cross section illustrated in figure 5. Here, the regions shown with the designation 42 have housing material, that is to say molding compound, instead of leadframe material. However, the housing material is substantially less stable than the leadframe material. The cross-sectional course of figure 5 can therefore be loaded less mechanically as compared with the cross-sectional course of figure 4.

The lowest ability to be loaded mechanically is exhibited by the cross-sectional course of figure 6. This cross section runs in the region of the axis of symmetry of the leadframe from figure 3. Since, as can be seen well from figure 3, no connecting fingers run in the axis of symmetry, the cross section in figure 6 does not have any leadframe material either. This region therefore constitutes a potential weak point in a semiconductor component, at which cracks in the

housing can arise as a result of mechanical or thermal loadings.

This potential weak point does not exist in the leadframe according to the invention according to figure 1, since there there are no cross-sectional faces which have no leadframe material. The single exception is represented by a sectional face at right angles to the course of the connecting fingers. Because of the principle, this is the case in leadframes in which the connecting fingers extend from two opposite sides in the direction of the central region 14. In the case of a leadframe in which the connecting fingers extend from all four sides in the direction of the central region, the connecting fingers would run in such a way that even the further axis of symmetry would be crossed by connecting fingers.

In principle, the connecting fingers can assume any conceivable course. However, since the electrical signal characteristics of each connecting finger have to be taken into account, it is expedient to change the course of only those connecting fingers which lie adjacent to a sectional face which from the outset has no leadframe material.

Various embodiments of connecting fingers 12 are illustrated in figures 2a to 2c. The connecting fingers 12 are in each case illustrated in a plan view. According to the exemplary embodiment of figure 2a, a connecting finger 12 can have a paddle-like reinforcement 24. The reinforcement, which corresponds to a broadening of the connecting finger 12 in a sub-area does not have to have the shape shown in this case but - depending on the space available - can be given any desired shape. Another exemplary embodiment is illustrated

in figure 2b, in which the reinforcement is designed in the shape of an anchor. In this case, the anchor can of course also be aligned in the other direction.

By means of optimum guidance of the connecting finger regions located in the interior of a housing, whilst taking account of known design rules, the invention proposes keeping the critical housing cross section, that is to say the cross section without leadframe material, as small as possible. The leadframe is preferably designed in such a way that the relationship of leadframe material to the other materials (chip, housing) is approximately the same. By this means, potential weak points in a semiconductor component can be avoided.

Patent claims

1. A leadframe of a conductive material, having a central region (14) to accommodate a chip, and a plurality of connecting fingers (12) which extend at least from one side in the direction of the central region (14), a contact region (34) being provided adjacent to the central region (14) on at least some of the connecting fingers (12), and the course of the connecting fingers (12) being such that the sectional face in any imaginary cross section at right angles to the main face of the leadframe (10) has leadframe material, whereby the relationship between leadframe material and the other material occurring in the semiconductor component is approximately the same.

2. The leadframe as claimed in claim 1, in which the connecting fingers (12) are arranged in such a way that they cross at least one of the sectional faces (36).

3. The leadframe as claimed in claim 1 or 2, in which at least those connecting fingers (12) which are adjacent to the axis of symmetry of the leadframe (10) cross the axis of symmetry.

4. The leadframe as claimed in one of claims 1 to 3, in which the connecting fingers (12) have material reinforcements (24), so that the material reinforcements cross at least one of the sectional faces (36).

5. The leadframe as claimed in claim 4, in which at least those material reinforcements of the connecting fingers (12) which are adjacent to the axis of symmetry of the leadframe (10) cross the axis of symmetry.

6. The leadframe as claimed in claim 4 or 5, in which the connecting fingers (12) which have material reinforcements (24) are not intended to perform a critical electrical function.

7. The leadframe as claimed in one of claims 4 to 6, in which connecting fingers (12) with material reinforcements (24) and connecting fingers (12) without material reinforcements are arranged alternately.

8. The leadframe as claimed in one of claims 4 to 7, in which the reinforcements (24) have the shape of an anchor or a paddle.

9. A component comprising a chip (26), a leadframe (10) of a conductive material, having a central region (14) and having connecting fingers (12), and a housing (32) of a molding compound, the chip (26) having contact pads (30) on its upper side (28) which are connected electrically to the connecting fingers (12), and the housing (32) enclosing the chip (26) and regions of the connecting fingers (12), and the course of the connecting fingers (12) in the interior of the housing (32) being such that the sectional face in any arbitrary imaginary cross section at right angles to the main face of the semiconductor component has leadframe material, whereby the relationship between leadframe material and the other material occurring in the semiconductor component is approximately the same.

10. The component as claimed in claim 9, in which the leadframe (10) is constructed as claimed in one of claims 1 to 8.

List of designations

10 Leadframe
12 Connecting finger
14 Central region
16 Sealing web
18 Contact point
20 Inner region
22 Outer region
24 Reinforcement
26 Chip
28 Upper side
30 Contact pads
32 Housing
34 Contact region
36 Sectional face
38