

Method for manufacturing an electronic component and electronic component

The present invention relates to the field of electrical engineering and concerns an electronic component with at least one electronic element that is electrically connected to a segment of a strip made of a carrier material by means of wire bonding, a method
5 for manufacturing such an electronic component, and a coil formed by a strip of a carrier material and provided for a wire bonding process as part of this manufacturing method.

The reliability and service life of contact systems in switching devices and electro-mechanical and electronic components often depend not only on the contact material used. The choice of a suitable carrier material also plays a decisive role.

10 Copper-based materials are the most important carrier materials. Depending on the application, nickel-based materials or multilayer composite materials, e.g., thermo-bimetals, are also used.

The requirements placed on the substrate materials are diverse, depending on their different applications. For example, copper materials are required to have high
15 electrical and thermal conductivity, good strength properties even at elevated temperatures, and sufficiently high corrosion resistance. If the substrate materials are used as contact springs, the material must also have good spring properties. In addition, depending on the manufacturing process, a number of technological properties must also be mentioned, such as good hot and cold formability, machinability, stampability, welda-
20 bility, solderability, and electroplating capability.

Materials made of copper and copper alloys intended for use in electrical engineering and electronics are usually specified in standards. The substrate material of the present invention, which is standardized according to DIN, is in particular a material according to DIN EN 1758.

25 In electronics and electrical engineering, a corresponding carrier material is not usually used exclusively for conducting electricity, in particular power current. Sometimes, electronic components such as transistors, light-emitting diodes, or photodiodes are also connected directly to the carrier material.

Wire bonding is an electrical connection technique in which a thin wire (e.g., AU, 30 Al) with a diameter in the range of 50 to 300 μm is welded to a flat metal surface or a semiconductor element surface by means of high-frequency mechanical excitation. This

joining process is often used in semiconductor devices for the electrical connection between the semiconductor and the system carrier, which is usually made of a copper alloy strip.

5 The wire bonding process requires a flawless surface. In the rolling production of the carrier material, which is supplied in the form of a wound ring/coil, the surface comes into contact with metallic tools (rollers, straightening rollers) and rollers for deflection in many process steps. In the process, imperfections and particles on the tools or rollers can be transferred to the surface of the carrier material. In addition, relative movement between the coils, e.g., during transport, can cause scratches and other defects in the surface that render it unsuitable for use in the wire bonding process. In order to achieve the flawless surface required for the wire bonding process, extensive measures have therefore been necessary in the production of the carrier material and in testing.

15 The present invention aims to provide a solution to the problems described above. According to a first aspect, the present invention provides a method for manufacturing an electronic component with at least one electronic component that is electrically connected to a segment of a strip made of a carrier material by means of wire bonding. In this method, the strip is rolled in a manner known per se by rolling a base material. The surface formed by rolling is removed to form an exposed contact point on the strip, which is formed by the base material. The rolled strip is then wound into a coil. The contact point is usually formed before the coil is wound up, preferably by passing it through a processing station at the feed rate specified by the rolling process, where the contact point is formed. This can be formed by chip removal machining, preferably in the rolling direction.

25 The coil produced in this way is then usually made ready for shipment as part of the overall process, for which purpose the coil is placed on a transport pallet and secured or fastened to it with transport securing means. The invention is guided by the idea that the coil is produced in a metalworking operation and that the further processing steps, in particular wire bonding for the electrical connection of the electronic component, are carried out in an electrical engineering operation to which the coil is transported.

30 There, the rolled strip is unwound from the coil and the segment is separated from the strip. For the electrical connection of the electronic component, a wire is then

bonded electrically conductively at the contact point. This wire can be bonded simultaneously to the electronic component.

The coil is formed by a strip of a carrier material. The strip is formed by rolling a base material and has a surface formed by rolling. According to the present invention, at least one contact point exposed on the strip is formed on the strip-shaped carrier material, at which the surface formed by rolling is removed. The contact point is therefore lower in height than the surface formed by rolling. The contact point is therefore spaced from the surface formed by rolling in the direction of the center of the carrier material. It exposes the base material of the coil and is formed by this base material. The contact point is preferably formed only locally on the strip, which means that the contact point is otherwise completely or partially surrounded by the surface formed by rolling. The contact point can be formed as an elongated streak continuous in the rolling direction. In this case, the contact point is surrounded on one side, preferably on both sides, by the surface formed by rolling. The contact point can also be formed at specific points and thus be completely surrounded by the surface formed by rolling.

The contact point serves to remove the impurities and modifications of the base material produced by rolling close to the surface. This base material is free of indentations, scars, and disruptive foreign particles at the contact point. In this way, the topographical and material requirements of the wire bonding process can be taken into account. Even if the wire bonding process requires a previously applied electroplated coating of the contact point, the conditions for the bonding process are significantly improved compared to those of the rolled surface. Since the contact point is also deeper than the surface formed by rolling, the contact point cannot be impaired by relative movement of adjacent windings during transport. A carrier material with a defined contact point can then be supplied to a processor of the carrier material in electronics or electrical engineering, even in the form of a coil with a large number of windings.

One of the contact points is usually located on one or, if necessary, two opposite surfaces of the strip, which are formed by rolling. This wording is intended to express that the strip has two main side surfaces that have a significantly greater extent than the end surfaces connecting these main side surfaces. These end surfaces may also be processed by rolling. However, they are not necessarily formed by rolling. The at least one contact point is located on the main side surface.

It is understood that, with regard to mass production and the use of a coil in such production, the contact points are usually formed at fixed predetermined locations on the strip at cyclical intervals from each other. In this way, the respective electrically conductive carriers for use in electronics or electrical engineering can be separated from the coil from length sections of the strip-shaped carrier material. The contact point is usually located between the individual cut edges, through which a length of the strip is isolated from it.

As mentioned above, the base material is preferably a copper alloy. The strip preferably complies with the specifications of DIN EN ISO 1758.

As mentioned above, the contact point is lower than the surface formed by rolling. The contact point is usually between 30 μm and 150 μm away from the surface formed by rolling.

At the contact point, the material forming the surface formed by rolling is preferably removed by cutting.

This can preferably be done by peeling or scraping the surface of the finished rolled strip material. During peeling or scraping, the tool remains stationary. The workpiece is moved relative to it. In contrast to milling, this type of material processing does not cause any visible structures on the surface perpendicular to the rolling direction. These structures perpendicular to the rolling direction can be unfavorable for the bonding process, since the wire is also bonded to the surface perpendicular to the rolling direction. The present invention therefore also relates to a coil formed by a strip of a carrier material for a component used in electronics or electrical engineering, wherein the strip has a surface formed by rolling a base material. The strip has at least one exposed contact point for a wire, which is electrically connected to the contact point by wire bonding. At the contact point, the surface formed by rolling is removed by scraping. The base material of the coil is exposed at the contact point.

Each of the contact points usually has a width of between 2 and 10 mm.

To manufacture the coil according to the invention, a process is used in which a strip is first produced by rolling a base material. Material from the carrier material is locally removed from the surface of the strip formed by rolling in order to form the contact point exposed on the strip, preferably in the manner described above. The strip material is then wound up to form a coil.

Prepared in this way, the strip material is either fed by the manufacturer of the carrier material to an electroplating process, as required, or it goes to a punching machine which unwinds the strip from the coil at the place of use and punches, for example, system carriers for semiconductors, either as cut-to-length pieces or as wound punched strip. These and subsequent processes are then comparable to those used for material for which no surface removal takes place in the area of the wire bonding and are state of the art.

Further details and advantages of the present invention are apparent from the following description of embodiments of the invention in conjunction with the drawing, which shows:

- Figure 1 a perspective cross-sectional view of a length of a strip;
- Figure 2 a perspective view of a coil with the end of the strip forming this coil;
- Figure 3 a side view of a bonded circuit breaker using the strip according to Figure 1;
- Figure 4 a top view of Figure 4; and
- Figure 5 a perspective view of a unit ready for shipment.

Figure 1 shows an example of a carrier material, namely CuSn6 R500. The example illustrates a cross-sectional view through a longitudinal piece 2 of a strip 4 transverse to the rolling direction, indicated by the arrows with reference numeral W. The strip 4 has a thickness S of approximately 0.8-0.02 mm and a width B of 30-0.02 mm.

Reference sign 6 indicates two contact points near the edge of strip 4, which are formed by machining the surface 8 created by rolling. In the example, the distance A between this contact point 6 and each edge of the longitudinal piece 2 is 10 mm. The length L and the distance A are each measured transversely to the rolling direction. This machining forms the contact point 6 in a base material BA of the strip below the surface 8 in the height direction, with which the strip was produced from the melt and rolled to the desired thickness S. Reference sign M in Figure 1 indicates a region close to the surface of the rolled strip 4 which may be undesirably modified by the rolling process for electrical connection by means of wire bonding.

The contact point 6 is bordered at the transition to the surface 8 at an angle of 45° and has a width b of 5 mm. As the reduced thickness dimension R illustrates, the strip 4 is only 0.77 mm +/- 0.012 mm thick at the contact point 6. This reduced thickness of the strip 4 is achieved by machining the surface 8 of the strip 4. The reduced thickness R is

selected so that the modified surface area M is reliably removed by the material removal and the strip 4 with its base material B is exposed within the contact point 6, so that the predetermined material properties of the strip are present there.

In the embodiment shown, the contact point 6 was created by a peeling process.

5 This would allow generating a surface roughness in the rolling direction of $R_a=0.018\text{ }\mu\text{m}$ and R_{max} of $0.705\text{ }\mu\text{m}$ at the contact point 6. The roughness in the transverse direction, i.e., perpendicular to the longitudinal direction, was $R_a=0.173\text{ }\mu\text{m}$ and $R_{\text{max}}=1.228\text{ }\mu\text{m}$.

Figure 2 shows an example of a coil 10 formed from a strip 2 modified from Figure 1. As shown by the representation of the free end of the strip 2 in Figure 2, this strip 4
10 has only a single contact point 6 compared to the embodiment shown in Figure 1. For details of this contact point 6, reference can be made to the previous description of Figure 1.

Figures 3 and 4 show the attachment and connection of a semiconductor switch 12 to the strip 4 according to Figure 1. This strip is divided into several segments 14 by
15 punching, of which the segments 14.1 form busbars for the power current switched by the semiconductor switch 12. These segments 14.1 are each formed by punching the edges of the strip 4. The semiconductor switch 12 is electrically connected to one of the segments 14.1 via its wire bridges/pins 16.

Segment 14.2 was punched out from the center of strip 4. In the embodiment
20 shown, it carries the power switch 12 and serves as a busbar for the polarity to be switched by the semiconductor switch 12.

The extension of segment 14.2 in the rolling direction corresponds to the sum of the extensions of segments 14.1 in the rolling direction on one side of segment 14.2.

Figure 5 illustrates an example of a shipping unit 18 comprising the coil 10, a pallet
25 20, and securing straps 22.

At the operating facility equipped with the strip 4 with the contact point 6, the strip 4 is wound into a coil 10 after the contact point 6 has been formed, placed on the pallet 20, and secured for transport using the securing straps 22. Prepared in this manner, the unit 18 is ready for shipment to the operating facility where the bonding is performed.

List of reference signs

	2	Length piece
	4	Strip
5	6	Contact point
	8	Surface
	10	Coil
	12	Semiconductor switch
	14.1	Segment
10	14.2	Middle segment
	16	Wire bridges/pins
	18	Shipping unit
	20	Pallet
	22	Securing strap
15	A	Distance
	B	Width of the strip
	b	Width of the contact point
	R	Reduced thickness
	S	Thickness
20		

Claims

1. Method for manufacturing an electronic component with at least one electronic element (12) that is electrically connected by wire bonding to a segment (14.1) of a strip (4) made of a carrier material, wherein
 - the strip (4) is rolled by rolling a base material,
 - the surface (8) formed by rolling is removed to form a contact point (6) exposed on the strip (4), which is formed by the base material,
 - the rolled strip (4) is wound into a coil (10),
 - the rolled strip (4) is unwound from the coil (10) and the segment (14.1) is separated from the strip (4), and
 - a wire (16) is bonded in an electrically conductive manner in the contact point (6) for the electrical connection of the electronic component (12).
2. Method according to claim 1, **characterized in that** the contact point (6) is produced continuously in the rolling direction (W) by removing surface material from the carrier material.
3. Method according to claim 1 or 2, **characterized in that** a carrier segment (14.2) is separated from the strip (4) and that the electronic element (12) is mounted on the carrier segment (14.2).
4. Method according to one of the preceding claims, **characterized in that** the surface (8) formed by rolling is removed in such a way that the contact point (6) is bounded on at least two sides by the surface (8) formed by rolling.
5. Method according to one of the preceding claims, **characterized in that** the surface (8) formed by rolling is removed by scraping.
6. Shipping unit (18) comprising a coil (10) formed by a strip (4) of a carrier material of a component used in electronics or electrical engineering, wherein the strip (4) has a surface (8) formed by rolling a base material, and a transport pallet on which the coil (10) rests and to which the coil (10) is securely connected for transport, **characterized by** a contact point (6) exposed on the strip (4) for a wire (16) which is electrically connected to the contact point (6) by wire bonding

- (6), wherein at the contact point (6), the surface (8) formed by rolling is removed and the base material of the coil (10) is exposed.
7. Shipping unit (18) according to claim 6, **characterized in that** the base material is a copper alloy.
 8. Shipping unit (18) according to claim 6 or 7, **characterized in that** the strip (4) complies with DIN ISO 1758.
 9. Shipping unit (18) according to one of claims 6 to 8, **characterized in that** at the contact point (6), the surface (8) formed by rolling is removed by a distance (A) of between 30 μm and 150 μm from the surface (8) formed by rolling.
 10. Shipping unit (18) according to one of claims 6 to 9, **characterized in that** at the contact point (6), a material forming the surface (8) formed by rolling is removed by cutting.
 11. Shipping unit (18) according to claim 10, **characterized in that** the material forming the surface (8) is removed by scraping.
 12. Shipping unit (18) according to one of claims 6 to 11, **characterized in that** the contact point (6) has a width (b) between 2 and 10 mm.
 13. Shipping unit (18) according to one of claims 6 to 12, **characterized in that** the contact point (6) is bounded on at least one side by the surface (8) formed by rolling.
 14. Electronic component with at least one electronic element (12) that is electrically connected by wire bonding to a segment (14.1) of a strip (4) made of a carrier material, wherein the segment (14.1) has a surface (8) formed by rolling a base material (8) formed by rolling and an exposed contact point (6) at which the surface (8) formed by rolling has been removed, the contact point (6) being formed by the base material of the coil, to which a wire electrically connecting the electronic component (12) to the segment (14.1) is bonded.

15. Electronic component according to claim 14, **characterized by** a carrier segment (14.2) formed from the strip (4), on which the electronic element (12) is mounted.