

Electronic Object

The invention concerns an electronic object.

In the sense of the invention, electronic objects are understood to be articles which have at least one electronic element which is embedded in a body of plastic material. These electronic objects may be thin, flat articles along the lines of chip cards or more voluminous articles along the lines of labels, so-called tags, or toys or communication equipment or electrical connectors. The electronic element can be, for example, a semiconductor chip, a ferrite core, a capacitor or a resistor and it is usually fixed on a system carrier arranged in the body. The system carrier can be a metallic leadframe or a flextape or a foil or the like containing at least one layer of non conducting material and at least one structured metallic layer. The body consists of plastic which is injected around or onto the system carrier. The system carrier is essentially located within the body but has contact pads for the electrical connection to an external device which lie flush with an outer surface of the electronic element. The contact pads are formed by corresponding parts of the system carrier which are generally electro-plated and which are generally bent out from the plane at which the system carrier is essentially arranged. For all electronic objects along the lines of chip cards as well as for numerous electronic objects with more voluminous bodies, the bent out areas of the contact pads of the system carrier are generally connected to the remainder of the system carrier via one or more bends or right-angle bends, whereby the contact pads themselves are often again arranged parallel to the plane of the system carrier. To produce the body, the system carrier is placed in a die cavity where it is arranged and secured in such a way that it lies with the contact pads on an inner surface of the die cavity. Subsequently, the plastic is injected into the remaining space of the die cavity and if necessary compressed and then the finished electronic object is removed from the die cavity. In the outer surface of the finished electronic object, the contact pads and the plastic forming the body are adjacent to one another and it is desirable that the border between each contact pad and the plastic follows a precisely defined contour, for example a straight line or a specified curve. If the electronic object has several contact pads, which is generally the case, then not only should each border of an individual contact pad follow such a defined contour but all borders should be located on a defined contour, for example a straight line, a circular line or any other geometrically determined contour.

It has now become apparent that it can occasionally be difficult to produce electronic modules which fulfill the requirements just described in relation to such borders between the contact pads and the plastic of the body. The reason for this can be seen in that the bends or right-angle bends of the system carrier on the transition to the contact pads demonstrate a certain rounding off. This can have the consequence that, on injection of the plastic, the plastic in the area of the rounded bend is somewhat wedge-shaped and seeps quite randomly between the bordering areas of the die cavity and the system carrier which can then

have the further consequence that, in the finished plastic object, the border between the plastic and the contact pads does not lie as intended on a defined contour, for example a straight line or a circular line.

This can however be rectified at least to a large extent if a very small bending radius is selected for the rounding off of the bend of the system carrier, but there are various reasons against the selection of such small bending radii. Firstly, on production of bends with small bending radii, there is the danger of fissuring in the system carrier itself. Secondly, sharply bent contact pads have the tendency of deforming into grooves in the area of the bend, such grooves having in cross-section the shape of a flat U; such grooves can then fill with plastic on production of the body. For parts completely embedded in the plastic this is mostly unimportant, but for the contact pads visible on the outer surface this can possibly lead to visibly undesirable, somewhat crescent-shaped borders between the contact pads and the plastic of the body which are often undesirable, particularly for esthetic reasons. Thirdly, problems occur in connection with the electro-plating of the contact pads; as namely electro-plating of the area of a sharp bend can be problematic after producing the bend, the electro-plating should be carried out on the not yet deformed system carrier; this means however, that not only the system carrier but also the layer deposited onto it by the electro-plating must be bent, whereby small cracks can occur in the electro-plated layer; mostly, these cracks do not impair the electrical function of the contact pads, however they form access ways to the system carrier through which foreign material can penetrate from the environment which could attack the system carrier. Therefore, as demonstrated above, the problem of the non-defined borders between the plastic of the body and the contact pads can not be optimally rectified by the selection of small bending radii for the bends of the system carrier.

A further problem with the production of electronic objects lies in the assembly of the system carrier with electronic elements. For example, to secure semiconductor chips to the system carrier, an adhesive layer, for example a drop of adhesive, is deposited onto a chip island of the system carrier. The semiconductor chip is subsequently deposited onto this adhesive layer. Finally, the semiconductor chip which adheres with its underside to the system carrier is encapsulated from the side and above by a plastic capsule made of plastic which is supplied in free-flowing form and subsequently hardened. The plastic capsule produced in this way takes the place of the previously common plastic housing produced by means of an injection or casting process in a mould with which the semiconductor chip was extrusion coated or cast. The production of such a plastic capsule for which no mould is necessary is obviously simpler and more efficient than the production of an injected or cast plastic housing, however the danger exists that the plastic supplied in free-flowing form does not harden quick enough or, with too low a viscosity, flows away laterally so that a perfect plastic capsule is not created. In order to prevent this, attempts have been made, before production of the plastic capsule on the system carrier, to attach a form of elevation or dam of a different type of plastic which has a very high viscosity and/or cures very

quickly. An elevation produced in this way has the disadvantage of a time consuming and, because of the additionally required plastic, relatively expensive production.

The object of the invention is therefore seen in the creation of an electronic object on whose outer surface the transition between the plastic of the body and the contact pads runs precisely along a defined contour, for example a straight line, a circular line or another specified curve. An additional object of the invention is to create an electronic object with which the plastic capsule embedding the electronic element can be produced with a well defined shape in a simple manner.

In this way, the system carrier of the electronic object in accordance with the invention, contains a step in the area of the start of its bending away from the outer surface of the electronic object. The step has a depth of typically 30 to 50 μm . The production of this step with an upper edge running along a defined contour is technically possible. The step projects from the surface of the system carrier facing the outside of the electronic object back towards the inside of the system carrier. Seen from the outside of the electronic object, the upper edge of the step forms the border between the contact pad and the plastic of the body. The bending radius of the bend in the system carrier can now be selected large enough to avoid the problems of smaller bending radii described above. By means of the step in the system carrier, it can be achieved, that the system carrier goes away from the outer surface of the electronic object immediately at the start of the bend, preferably at an angle of at least close to 90° , as would be the case when a conventional system carrier is used without step, but with a bend having a minimal bending radius. By means of the step, a defined border is achieved between the contact pads and the plastic as intended. By means of the new shape of the system carrier, all the disadvantages of conventional system carriers described above can be avoided.

The contour on which the border between the plastic and each contact pad or between the plastic and neighbouring contact pads, respectively, lies, can be a straight line, a circular line or any other specified curve.

Preferably, the backward projecting step forms one border of a flat recess of the system carrier, whereby the other border of the recess is formed from a corresponding forward projecting step. Alternatively, the bottom of the recess could slope.

The recess can be produced by removing material by means of cutting, galvanising or laser effect or by means of a deformation such as, for example, by stamping the surface of the system carrier. The recess can be produced before or after bending the system carrier; on producing the recess before bending, an

additional advantage is achieved, namely the improved flexibility of the system carrier as a result of the reduced wall thickness.

The step can be produced in that a system carrier is used which consists of two connected foil parts of different wall thicknesses, whereby the foil part with the greater wall thickness forms the contact pads and the foil part with the lesser wall thickness forms the area of the foil bent towards the inside of the electronic object; in this way, the foil lies in the die cavity during injection of the body or later in the electronic object, respectively, in such a way that the transition between the foil parts forms the upper edge of the backward projecting step.

The electronic object can also be developed so that it has at least one further contact pad which is arranged in series with at least one of the first-named contact pads and is connected to the rest of the system carrier on both sides via further bends. The system carrier can then be formed so that, in the area of each bend, it has a further backward projecting step which is developed and arranged in the same way as the step described above.

Electronic objects with several contact pads arranged in series are preferably developed so that these contact pads are arranged in different outer surfaces of the electronic element.

The outer surfaces of the electronic object or the contact pads arranged within it can be flat, single or multiple bent.

The elevation with which the spread of the free-flowing plastic and finally the plastic capsule itself is limited consists in accordance with the invention of a step to which a corresponding area of the system carrier, for example a ring area, is formed which surrounds that surface of the system carrier to which the semiconductor chip or, if necessary, a different electronic element is secured. The lower edge of the step thereby lies at the height of the surface to which the electronic element is secured so that this is located in a recess.

The recess can be produced in the same way, namely by means of a material removing or material deforming process, like the recess in the area of the contact pads of the system carrier described above.

The invention is described in detail below based on exemplary embodiments.

It is shown, in:

- Fig. 1A** a first electronic object arranged in a die cavity according to the prior art, after injection of the plastic forming the body with a system carrier which has bends with a large bending radius, by extracts, in one section;
- Fig. 1B** a front view of the electronic object presented in Fig. 1A;
- Fig. 2A** a second electronic object according to the prior art with a system carrier which has bends with a small bending radius in the same presentation as Fig. 1A;
- Fig. 2B** the electronic object presented in Fig. 2A in the same presentation as Fig. 1B;
- Fig. 2C** the electronic object presented in Figs. 2A and 2B in a section along the line II - II of Fig. 2A;
- Fig. 3A** a first electronic object according to the invention in the same presentation as Figs. 1A and 2A;
- Fig. 3B** the electronic object presented in Fig. 3A in the same presentation as Figs. 1B and 2B;
- Fig. 4** a third electronic object according to the invention, whereby the step on the transition is formed by parts of the system carrier with differing wall thicknesses, in the same presentation as Figs. 1A, 2A and 3A;
- Fig. 5** a fourth electronic object in accordance with the invention, whereby the border between the plastic and the contact pads lies on a circular line in the same presentation as Fig. 3A;
- Fig. 6** a fifth electronic object in accordance with the invention with an additional contact pad arranged in series to the first-mentioned contact pad in the same presentation as Figs. 3A and 4;
- Fig. 7** a sixth electronic object in accordance with the invention with a total of three contact pads in the same presentation as Figs. 3A, 4 and 6;
- Fig. 8** a seventh electronic object in accordance with the invention with a cylindrical body, in extracts, in one section at right angles to its longitudinal axis;

- Fig. 9 a system carrier with a semiconductor chip attached to it, arranged in a recess and surrounded by a plastic capsule, by extracts in one section;
- Fig. 10 a system carrier with a semiconductor chip attached to it, arranged in a recess and surrounded by a plastic capsule, by extracts in one section, whereby the recess is formed by the removal of one layer of the two-layer system carrier in the same presentation as Fig. 9; and
- Fig. 11 a system carrier with a semiconductor chip attached to it and surrounded by a plastic capsule in one section, whereby the system carrier demonstrates a recess running around the semiconductor chip.

Fig. 1A shows an electronic object 10 according to the prior art in a die cavity which is limited by two parts of a mould 8, 9. The electronic object 10 comprises a body 12 of injected plastic and a system carrier 14. The system carrier 14 can be a metallic leadframe or a flextape containing a structured metallic layer. Essentially, the system carrier 14 lies parallel to the body 12 of the relatively thin electronic object 10 and has a border area with several slits (not visible in Fig. 1) thus forming several separated contact pads 16 by means of which the electronic object 10 can be electrically connected to an external device. Three contact pads 16 are shown in Fig. 1B. Each contact pad 16 is bent out from the level of the central area 20 of the system carrier 14 by a first bend 18 and a second bend 19. By means of the bends 18 and 19, a type of gate 22 and the contact pad 16 are formed, whereby the gate 22 runs diagonally and the contact pad 16 parallel to the central area 20 of the system carrier. The bends 18 and 19 have relatively large bending radii and the plastic of the body 12 forms a type of wedge 24 between the mould part 8 and the contact pads 16. On the outer surface 11 of the electronic object 10 which is visible in Fig. 1B, the three contact pads 16 lying flush with this outer surface 11 or their surfaces 17 facing the outside of the electronic object 10, respectively, are visible. As a result of the random shapes and dimensions of the wedges 24, the borders between the contact pads 16 and the plastic of the body 12 do not lie on a straight line 26 as desired.

Figs. 2A, 2B and 2C also show an electronic module 10 according to the prior art, constructed in principle in the same way as the electronic module presented in Figs. 1A and 1B, however with the difference that the bends 18 and 19 have relatively small bending radii. In this way, the formation of the wedges 24 is largely avoided, however, because of the bending process, U-shaped, groove-type deformations 25 are created in accordance with Fig. 2C in the area of the bends 18 and 19 which fill with plastic on production of the body 12. This has the consequence, in accordance with Fig. 2B, that with such electronic objects 10 the borders between the individual contact pads 16 and the plastic of the body 12

are not essentially offset against one another but that the border of each contact pad 16 runs in a sort of crescent because the plastic fills the U-shaped groove-type deformations 25.

Fig. 3A shows an electronic module 10 according to the invention with a system carrier 14 in the form of a metallic leadframe. In the area of the bend 19 which borders on the contact pads 16 the system carrier 14 has a step 30 projecting backward from its surface 17 directed to the outside of the electronic object 10. This step 30, together with a further forward projecting step 32 in the gate-type part 22 of the system carrier 14, limits a flat recess 34 in the system carrier 14 by means of which the wall strength of the system carrier 14 is reduced locally. The step 30 has the consequence that the system carrier 14 goes away from the part 8 of the mould practically at right angles, whereby the upper edge of the step 31 forms a precisely defined limitation for the plastic of the body 12 so that, on the outer surface 11 of the finished electronic object 10, the border between the plastic and the contact pads 16 comes to lie on a straight line 26 as can be seen in Fig. 3B.

Fig. 4 shows a further electronic module 10 according to the invention which is constructed similarly to the electronic object in Figs. 3A and 3B. As opposed to the system carrier 14 of the electronic object in accordance with Figs. 3A and 3B whose wall thickness is the same overall, the electronic module 10 according to Fig. 4 has a system carrier 14 which comprises two foil parts 14.1 and 14.2 which are connected together. The contact pads 16 are formed from the foil part 14.1; whereby the wall thickness of the foil part 14.1 is greater than the wall thickness of the foil part 14.2. In this case, the foil 14 is arranged in the die cavity or in the finished electronic object 10 so that the step 30 is formed by the transition from foil part 14.1 to foil part 14.2. The plan view of the electronic object 11 in accordance with Fig. 4 is the same as the plan view presented in Fig. 3B of the electronic object according to Fig 3A:

In Fig. 5 a further electronic object 10 is presented whose contact pads 16 lie in a circular ring or are limited in the area of their bends by means of a circle 27.

Fig. 6 shows an electronic object 10 which contains a system carrier 14 which is formed so that it has a further contact pad 16.1 in addition to the contact pad 16, whereby the two contact pads 16, 16.1 are arranged on two outer areas of the electronic object 10 lying opposite and parallel to each other. The system carrier 14 has the step 30 or the recess 34 bordering on the contact pad 16 and two steps 30.1 or two recesses 34.1 bordering on the contact pad 16.1. The outer end of the system carrier 14 is sharp-edged so that here a perfect border is created between the plastic of the body 12 and the contact pad 16.

The electronic object 10 presented in Fig. 7 is a more voluminous electronic object in contrast to the chip-card shaped, flat electronic objects of Figs. 3A to 5. It has a system carrier 14 which also forms

contact pads 16, 16.1 on two outer surfaces of the electronic object 10, whereby these outer surfaces are not parallel but arranged at a mutual angle. Fig. 7 also illustrates a semiconductor chip 37 secured to the system carrier 14 surrounded by a plastic capsule 36 with its contacts 38. The steps 30, 30.1 or the recesses 34, 34.1 are developed and arranged corresponding to the steps and recesses according to Fig. 6.

If the system carrier used is a flextape then it is possible to have the contact pads 16 and 16.1 galvanically separated.

Fig. 8 shows a cylindrical electronic object 10 whose contact pads 16 run in the direction of the circumference and therefore form single bent surfaces. The steps 30 are arranged here so that they project backwards almost radially into the inside of the electronic object 10. In principle, contact pads 16 can also be developed with steps with multiple bent surfaces.

In the examples disclosed so far the system carrier 14 used was a metallic leadframe. As mentioned earlier the system carrier 14 can also be a flextape or the like containing at least a layer of non conducting material and a layer of metal. In this case the metallic layer which contains the contact pads 16 has to be provided with the steps 30, 32 or the recess 34, respectively, in the manner described above. One such example is shown in Fig. 8: The system carrier 14 can be the metallic leadframe or a foil consisting of a non conducting layer and a metallic layer as marked by the dashed line where the recess 34 was formed by local removal of the metallic layer.

The principle of creating a border following a defined contour for the plastic supplied in free-flowing form with the aid of steps in the system carrier can essentially be applied everywhere for electronic objects 10 or system carriers 14, respectively. As an example, Fig. 9 shows a system carrier 14 of a further electronic object 10 with a body 12. A semiconductor chip 40 is secured on the system carrier 14 by means of an adhesive layer 42 and is embedded in a plastic capsule 44. The semiconductor chip 40 is mounted in a recess 34 of the system carrier 14. On applying the plastic in free-flowing form for formation of the plastic capsule 44, the plastic stops flowing at the step 30 forming the border of the recess 34. The area occupied by the afterwards cured plastic capsule 44 is therefore well defined and restricted to the area of the recess 34.

Fig. 10 shows a system carrier 14 which is similar to the system carrier presented in Fig. 9 with the only difference that the system carrier 14 here is formed from two layers 14.3, 14.4 and that the recess 34 is created by local removal of the layer 14.4.

Fig. 11 shows a system carrier 14 with which the semiconductor chip 40 is not itself arranged in a recess, but a recess 34 running around the semiconductor chip 40 exists. On applying the plastic, the step 30 formed by the recess 34 in the system carrier 14 again effects the stopping of the still flowing plastic at the recess 34 and thereby a high reproducibility of the shape and size of the plastic capsule 44. The system carrier 14 could also be formed from two layers here, whereby the recess 34 is produced by local removal of the upper layer.



CLAIMS

1. Electronic object (10), comprising at least one electronic element mounted on a system carrier (14) and a body (12) of plastic, whereby the system carrier (14) has at least one contact pad (16) which lies flush with an outer surface (11) of the body (12), **characterized in that** the system carrier (14) has on its surface (17) directed towards the outside of the electronic module (10) a step (30) projecting backwards from this surface (17) the upper edge (31) of the step (3) forming a border for the plastic of the body (12).
2. Electronic object according to claim 1, characterized in that the at least one contact pad (16) is connected to another area (20) of the system carrier (14) via at least one bend (19) and that the step (30) is located near the transition from the pad surface to the bend (19).
3. Electronic object according to claim 1 or 2, characterized in that the steps (30) of several neighbouring contact pads (16) are formed in such a way that the border between the contact pads (16) and the plastic runs along a predefined line.
4. Electronic object (10) according to claim 1, 2 or 3, characterized in that the system carrier (14) is formed from two connected foil parts (14.1, 14.2) which have differing wall thicknesses, whereby the foil parts (14.1, 14.2) are arranged in such a way that the backward projecting step (30) is formed at the transition from the foil part (14.1) with greater wall thickness to the foil part (14.2) with lesser wall thickness.
5. Electronic object (10) according to at least one of the preceding claims, characterized in that it has at least one additional contact pad (16.1) arranged in series with the at least one contact pad (16) which preferably lies in a further outer surface of the electronic object (10) and is connected via bends (19.1) to the rest of the system carrier (14) whereby the system carrier (14) has a step (30.1) in the area of each of the bends (19.1).
6. Electronic object (10) according to at least one of the preceeding claims, characterized in that the contact pads (16) form flat or single or multiple bent surfaces.
7. Electronic object (10) according to at least one of the preceeding claims, characterized in that the contact pads (16, 16.1) are arranged in different outer surfaces of the electronic object (10).

8. Electronic object (10) comprising a system carrier (14) and an electronic element (40) secured to the system carrier (14) whereby the electronic element (40) is embedded in a plastic capsule (44), characterized in that the electronic element (40) is mounted in a recess of the system carrier (14) or in that a recess (34) in the system carrier (14) surrounds the electronic element (40), the step (30) of the recess (34) forming the border of the plastic capsule (44).

This Sheet Has Been Replaced

