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The present invention concerns soldering tools for electronic devices and more specifically those for simultaneously soldering a plurality of connector tabs to connector pads of a microplaquette of integrated circuits commonly known as a chip.

In order to accelerate and render more economical the automatic assembly of integrated circuit chips on supports, for example printed circuits or casing backs, a technique known as T.A.B., an abbreviation of Tape Automated Bonding, was developed.

According to this technique, the chips are firstly applied to a flexible tape of insulating material having perforations along its edges so that it can be driven like a movie film and groups of windows regularly arranged in its central part, each group comprising a principal window and secondary windows, often four of them, arranged around the principal window.

This tape also carries on one of its surfaces and for each group of windows a plurality of conductor strips which pass above the secondary windows or at least a given number thereof and extend beyond the edge of the principal window to form radially-extending connector tabs in a configuration corresponding to that of the connector pads of the chips. To fix the chips onto the tape each chip is placed under the principal window of one group so that its connector pads are located directly opposite the free ends of the connector tabs associated with this window and all of the ends are soldered simultaneously after having first applied onto said pads a fusible material such as tin.

Then, at least the front surface of the chips, i.e. the surface where the connector pads are located, is covered with a layer of opaque, electrically insulating, and hardenable adhesive material so that the just-formed solder joints are embedded therein, and these solder joints are tested. At the same time, the functioning of the integrated circuits can be tested.

When the tests are finished, the tape is cut around each chip following a contour bordering the outermost sides of the secondary windows to provide modules with external connector tabs formed by the parts of the conductor bands that originally were located above these secondary windows.

After this, all that remains to be done is to fix each module on the associated support which is done by soldering, also in one go, its external tabs, bearing thereon a suitable solder material, onto the corresponding conductors of this support.

This second soldering operation, often called

O.L.B., an abbreviation for Outer Lead Bonding, is usually carried out using a tool comprising at least one heating member or thermode fitted at the end of rods of conductive material electrically insulated from one another and which connect the thermode to a current generator.

After having so positioned the module with the chip that the tips of its connector tabs are located above the support conductors, the soldering tool is lowered such as to maintain through pressure the former in contact with the latter and the thermode, or each thermode if there are several, is supplied with a large current causing fusion of the solder material. Then, very rapidly, the supply to the thermode(s) is switched off, to allow the solder material to solidify again and the soldering tool is raised.

Of course, for such solder joints to be produced at high production rates and in a very reliable manner the thermodes that are used must meet a number of requirements.

Firstly, to enable heating cycles that are both very rapid and very precise, the thermodes must be made of a material having low resistivity and thermic inertia.

For the same reason, they must have a relatively thin structure, which can be obtained for example by cutting them out of sheet metal or a metal strip and, if there is only one thermode per tool, by bending or possibly by stamping.

Furthermore, to ensure correct soldering of all of the connector tabs to the support conductors, it is necessary that both the temperature distribution over their sole, i.e. the flat part that comes into contact with the tabs, should be perfectly uniform, and the material of which they are made should enable them to have a good mechanical strength and a contact surface of sufficient hardness whereby the pressure exerted on these tabs is also as uniform as possible.

The following materials are eminently suitable for thermodes of this type and are commonly used: titanium, some chromium steels and the alloy known under the trademark "Inconel" which is a nickel-based alloy containing also chromium and iron.

For the first soldering operation, i.e. the one for mounting the chips onto the tape, called I.L.B. (Inner Lead Bonding), tools of a different type are used in which the heating member is no longer heated intermittently by passing current pulses through it, but continuously and without the heating member being itself connected to a source of electricity. It is then made of a massive part fixed to the end of a holding member having at one end a generally rectangular sole whose dimensions are

adapted to those of the chips and, at the other end, a hole for housing a heating element, consisting of a resistor, and at least one further hole for receiving a thermocouple for controlling the temperature to which it is heated by acting on the current generator supplying the resistor.

In this case, the material or materials making up the heating member, which we will continue to call thermode, must be good conductors of heat and enable it to have a high thermic inertia. Moreover, the sole must be very hard and, of course, perfectly flat.

The soldering tools used most frequently at present and which fulfill these conditions best are those with a thermode formed of a body of the above-mentioned alloy Inconel which performs very well in the range of temperatures suitable for I.L.B., i.e. between 450 and 600°C, and a sole of diamond fixed to this body. These tools are very reliable but, because of the diamond, their cost price is high and it is not possible to use them for connecting large-sized chips which, roughly speaking, are those with a surface area exceeding 30 mm². However, such chips are becoming more and more common in view of the fact that more and more complicated circuits with more and more input and output pads are being integrated.

In addition to these diamonded-soled soldering tools are those having a thermode made entirely of ceramic, more precisely of beryllium oxide (BeO). These have the advantage of being much less expensive than the previously mentioned ones and of being suitable for chips of any size, but they are much less reliable, with a Vickers hardness that does not exceed 2000, whereas that of diamond is about 3000. Moreover, beryllium oxide dust produced during manufacture of the thermode is toxic, and fixing the thermode at the end of a holding member is complicated and often involves problems.

One object of the invention is to provide a soldering tool also specially intended for I.L.B., which is very satisfactory as regards the hardness of its contact surface, and which at the same time is very reliable and quite inexpensive.

Another object of the invention is to provide a tool composed of elements that are easy to make and assemble and which is not dangerous for the manufacturing personnel.

Finally, a further object of the invention is for this tool to be suitable for chips of any sizes.

These objects are achieved due to the fact that, in a soldering tool according to the invention which also comprises a holding member and a massive heating member with a flat part adapted to be applied

against connector tabs to be soldered and a housing for a heating device, this heating member comprises a body of tungsten and a layer of titanium nitride which covers at least said flat part of this body.

In fact, for reasons that will be given later, it is preferable that the layer of titanium nitride covers all of the body except over the surface where it is fixed to the holding member.

Other features and advantages of the invention will be apparent from the following description of a preferred embodiment made with reference to the accompanying drawings in which Figures 1 and 2 are views respectively in axial cross-section and from below of this embodiment of the soldering tool according to the invention.

The soldering tool shown in these Figures comprises a thermode 2 of generally cylindrical shape formed about half way up with a diametral hole 4 for housing a heating resistor, not shown, and, lower down, with another, smaller diametral hole 6 for receiving a thermocouple, not shown either.

Also, the upper and lower surfaces 8 and 10 of this thermode respectively have a central hole 12 which is relatively large and shallow and which receives the lower end of a holding member 14, and a rectangular boss 12 (see Figure 2) of constant height, which evidently constitutes the flat part or sole that comes to bear against the ends of the connector tabs to be soldered.

To illustrate this, there is also shown in chain-dotted lines in Figure 1, a chip a with two of its terminals b and two connector tabs c to which the latter are going to be fixed.

According to the invention, the thermode 2 is made of a body 18 of tungsten which defines its shape and a layer 20 of titanium nitride (TiN) which entirely covers this body except facing the holding member 14.

This layer 20 whose thickness is preferably comprised between 1 and 4 micrometers serves two purposes:

Firstly, it enables the sole 16 to have a Vickers hardness of about 2300 whereas otherwise this Vickers hardness would only be about that of tungsten, i.e. about 400. It is clear that such a value (400) would be well below the hardness of diamond and even that of beryllium oxide. However, a Vickers hardness of 2300 is an intermediate value.

Secondly, it protects the body 18 against oxidation. Whereas tungsten enables the thermode to adequately fulfill the referred-to conditions of thermal conductivity and thermic inertia, it has the disadvantage of oxidising and of doing so at a rate

that increases as the temperature rises. Therefore, without the titanium nitride the sole 16 would not remain flat and clean for long.

The best way to go about forming the layer 20 is to begin by carefully cleaning the body 18, for example by placing it in an ultrasound-cleaning tank, and then to employ the nowadays very widely-used technique of physical vapour phase deposition generally known as P.V.D, an abbreviation for Physical Vapour Deposition.

This technique can be implemented in different ways. One way consists in introducing the part to be treated into an enclosure containing a titanium target, creating a high vacuum in this enclosure by pumping and then submitting the part to ionic etching at high voltage. When this etching step is finished, argon and gaseous ammonia (NH₃) are supplied to the enclosure and, by means of a very high frequency electromagnetic field, an electroluminescent discharge is produced which ionises the argon and creates a plasma. This plasma detaches titanium particles from the target and these particles react with the ammonia gas and deposit as titanium nitride on the part to be coated to form thereon a surface layer whose thickness depends on the duration of the operation.

By proceeding in this way, a layer of TiN adhering very well to the tungsten body may be obtained. The result would not be so good if other deposition techniques (which nevertheless should not be excluded) were used, and in particular Chemical Vapour Deposition or C.V.D.

Of course, as already mentioned, it would be possible to have a layer of TiN which covers the thermode 18 only at the location of the boss 16 or over the front surface of the body, but this would complicate the operation because at least the lateral surface of the body would have to be masked and the appearance of the tool would suffer.

Concerning the holding member 14, it can be seen in Figure 1 that this is made of a metal tube whose lower part has a number of crown-shaped cooling fins 22 and, facing the thermode, a bottom end 24 in which a hole 26 is bored.

This hole 26 enables a headless screw 28, having a non-threaded part housed inside a blind bore 30 situated at the centre and at the bottom of the above-mentioned hole 12 of the thermode and which is welded to the latter by brasing or using a laser beam, to penetrate inside the holding member and cooperate with a nut 32 to secure the holding member to the thermode.

To avoid having problems when the thermode is being heated, it is important that the holding

member 14, the screw 28 and the nut 32 be made of materials having very close coefficients of thermal expansion or, preferably, of the same material. This material may advantageously be Inconel, but it could also, for example, be nickel or stainless steel.

Furthermore, when the coefficient of expansion of the holding member's constituent material is much greater than that of tungsten, which is the case with Inconel (by a factor of about five), the diameter of the holding member's lower end must be slightly smaller than the diameter of the hole 12 in which it is located, as shown in Figure 1.

Lastly, this Figure also shows the presence of an indexing pin 34 which penetrates both in the thermode and in the bottom end 24 of the holding member for the purpose of holding these two parts in position relative to one another. This ensures that when the tool is placed in precise manner on a machine adapted to receive it, through means not shown in the drawings, the sole 16 will adopt a correct position in relation to the chips and connector tabs that pass in front of it.

Of course the invention is not limited to the just described embodiment.

Specifically, it would be possible to envisage a tool according to the invention other than for I.L.B., for example for soldering external tabs of a flat casing containing one or more chips on conductors carried by a support. For this, it would suffice to make a thermode with the desired dimensions, in particular as regards its sole, and to provide therein a cavity in which the above casing could be housed when soldering takes place. In this instance, the sole would of course not be full but would for example be made up of a planar part of the thermode comprised between two similar rectangles having coincident diagonals.

CLAIMS

1. A soldering tool for electronic devices intended especially for simultaneously soldering a plurality of connector tabs to connector pads of a chip and comprising a heating member (2) situated at the end of a holding member (14) and having a housing (4) for receiving means for heating it and a flat part (16) adapted to be applied against said connector tabs, characterised by the fact that said heating member comprises a body (18) of tungsten and a layer of titanium nitride (20) which covers at least said flat part of this body.

2. A soldering tool according to claim 1, characterised by the fact that said layer (20) entirely covers said body (18) except over a surface (8) adjacent the holding member (14).

3. A soldering tool according to claim 1 or 2, characterised by the fact that the thickness of said layer is comprised between 1 and 4 micrometers.

4. A soldering tool according to any one of claims 1 to 3, characterised by the fact that the holding member (14) comprises a metal tube having an inner end (24) in which there is a hole (26) and which is fixed to the heating member (2) by a screw (28) solid with the heating member, which screw passes through said hole and cooperates with a nut (32) situated inside said tube.

5. A soldering tool according to claim 4, characterised by the fact that the tube (14), the screw (28) and the nut (32) are made of the same material.

6. A soldering tool according to claim 5, characterised by the fact that said material is an alloy of nickel, chromium and iron.

7. A soldering tool according to any one of claims 4 to 6, characterised by the fact that said tube (14) has cooling fins (22).

