

The present invention relates to a process for the surface treatment, by dry means, of at least one metal surface portion, of the kind in which the portion is treated at a pressure close to atmospheric pressure  
5 by a treatment gas comprising excited or unstable species.

Such surface treatments may, for example, be used during processes for producing or for utilizing flat products or hollow bodies, in the production of  
10 electronic circuits such as printed-circuit boards, in order to carry out cleaning or fluxing, degreasing or surface-activation functions, often before a subsequent process, which may, for example, be an annealing operation, the electrodeposition of zinc, of aluminium,  
15 of tin or of their alloys, a brazing operation (for example for brazing electronic components on printed-circuit boards), or else the deposition of organic coatings, such as varnishes or paints, or inorganic coatings such as nitrides or silicon-based films.

20 In the field of the manufacture of printed-circuit boards, these steps for the treatment of metal surfaces are, especially, descaling, cleaning, connection-hole deflashing (or desmearing) or else fluxing before tinning or soldering.

25 Examples of such surface treatment processes, by dry means, are reported in the following documents: EP-658,391 and EP-658,637.

With regard to the soldering of electronic components on an electronic circuit, especially on  
30 printed-circuit boards, the two methods most commonly used for carrying out such a soldering operation are "wave soldering" and "reflow soldering".

In the technique of reflow soldering, a solder paste containing a mixture of a metal alloy and of a  
35 flux is deposited on the printed circuit at component connection points and then the components are placed on the board. The board furnished with components is then put into a reflow oven so as to provide a quantity of heat necessary to allow the metal alloy to melt and the  
40 fluxing element contained in the paste to be activated.

As regards wave soldering, this consists in bringing the boards bearing the electronic components to be soldered into contact with one or more liquid-solder-alloy waves obtained by a circulation of a solder bath contained in a tank, by means of a nozzle.

In general, the circuits are prefluxed in a region upstream of the wave-soldering machine, using a flux spray or a flux foam, and then preheated so as to activate the fluxes deposited beforehand, so as to clean the surfaces to be soldered, in order to remove the oxides and organic contaminants.

As in the case of reflow soldering, in order for the alloy to wet the metallizations and form the connections, it is necessary to descale the metallizations, that is to say the printed-circuit board and the components that it carries. This descaling is generally carried out by an agent which may be present in liquid or gaseous form.

In order to carry out a descaling operation by gaseous means, a flow of gas containing excited or unstable chemical species, directed onto the printed circuit, is used, this flow descaling the metallizations before the soldering step.

In this field of the fluxing, by dry means, of metal surfaces before soldering or tinning, the studies successfully concluded by the Applicant have shown that, in order to obtain effective descaling, it is necessary for the chemical species to treat all the metallizations, including the holes made in the connection points on the board and, moreover, the leads of the through-hole components.

It is therefore apparent that, in the currently available treatment methods by dry means, although the flow of gas treating the printed-circuit board is generally emitted in a direction approximately perpendicular to the latter, the flow naturally tends to be flattened so that the particles, and in particular the particles located on the periphery, tend to move tangentially to the surface of the board.

It may therefore be imagined that this type of descaling technique must be further improved, especially for the purpose of ensuring more effective and systematic descaling of the holes made in the board  
5 for insertion of the leads of so-called "leaded" or "insertable" electronic components.

One of the objectives of the present invention is to provide such improvements.

According to the invention, this objective is  
10 achieved in that the excited or unstable species have a velocity component substantially perpendicular to the surface.

The subject of the invention is therefore a process for the surface treatment, by dry means, of at  
15 least one metal surface portion, in which the portion is treated at a pressure close to atmospheric pressure by a flow of a treatment gas comprising excited or unstable species, characterized in that the pressure of the treatment gas on the metal surface is increased  
20 locally so as to force the chemical species to move in a direction approximately perpendicular to the said surface.

The process according to the invention may furthermore include one or more of the following  
25 characteristics:

- the treatment gas is substantially free of electrically charged species;

- the treatment gas is obtained from a primary gas mixture and, where appropriate, from an adjacent  
30 gas mixture, the primary gas mixture being obtained at the gas outlet of at least one apparatus for forming excited or unstable gaseous species, in which an initial gas mixture comprising an inert gas and/or a reducing gas and/or an oxidizing gas has been  
35 transformed, the adjacent mixture not having passed through the apparatus;

- since the flow of the treatment gas is emitted towards the surface in a direction generally perpendicular to the latter, and since it includes, on

the periphery, excited or unstable particles moving in a direction approximately tangential to the surface, the pressure of the flow of treatment gas on the surface is increased on the periphery of the flow;

5           - the pressure of the treatment gas on the surface is increased by means of at least one flow of an entrainment gas injected perpendicularly to the surface;

          - the entrainment gas contains nitrogen;

10           - as a variant, since the surface portion to be treated is placed in a treatment chamber, the pressure of the treatment gas on the surface is increased by means of at least one fan facing the surface so as to force the flow of treatment gas to strike the surface  
15 in a direction approximately perpendicular to the latter;

          - the excited or unstable chemical species are obtained by passing an initial gas through an electrical discharge; and

20           - the treatment gas containing the excited or unstable chemical species is produced from a reducing initial gas mixture comprising nitrogen and hydrogen.

An example of an apparatus for forming the excited or unstable gaseous species is described in the  
25 document EP-658,391 already mentioned.

The invention also relates to a process for the wave soldering of electronic components on an electronic circuit, during which:

30           - the components are placed at connection points made on the circuit;

          - an operation of fluxing the circuit is carried out by treating the latter, at a pressure close to atmospheric pressure, by means of a flow of a treatment gas containing excited or unstable chemical  
35 species; and

          - the circuit carrying the components is brought into contact with at least one wave of a solder alloy;

characterized in that, during the operation of fluxing the electronic circuit, the pressure of the treatment gas on the circuit is increased locally so as to force the chemical species to move in a direction  
5 approximately perpendicular to the circuit.

The subject of the invention is also an apparatus for treating at least one metal surface portion, by dry means, for the implementation of a process as defined above, characterized in that it  
10 comprises a source of treatment gas containing excited or unstable chemical species, a device for conveying parts comprising the said at least one metal surface portion, allowing the parts to be brought into contact with a flow of treatment gas, characterized in that it  
15 comprises means for locally increasing the pressure of the treatment gas on each part, so as to force the chemical species to move in a direction approximately perpendicular to the latter.

The subject of the invention is also an  
20 apparatus for the wave soldering of electronic components on an electronic circuit, for the implementation of a process as defined above, characterized in that it comprises a device for conveying circuits through at least one device for  
25 fluxing circuits, by treating the latter by means of a flow of treatment gas containing excited or unstable chemical species, the said circuits carrying, on at least one of their sides, the components to be soldered at connection points on the latter, then through a tank  
30 containing a solder alloy for the purpose of soldering the components, and in that at least one of the said fluxing devices includes means for locally increasing the pressure of the flow of treatment gas on each circuit so as to force the chemical species to move in  
35 a direction approximately perpendicular to the latter.

Other characteristics and advantages will emerge from the following description, given solely by way of example, and with reference to the appended drawings in which:

- Figure 1 is a diagrammatic representation of a wave-soldering apparatus according to the invention;

- Figure 2 is a diagrammatic representation, in cross section, of a device for forming excited or unstable chemical species, which is part of the fluxing device of the wave-soldering apparatus in Figure 1;

- Figure 3 shows a first embodiment of the means for locally increasing the pressure of the treatment gas on a part; and

10 - Figure 4 illustrates a second embodiment of the means for locally increasing the pressure of the treatment gas on a part.

Referring to Figure 1, a wave-soldering apparatus according to the invention comprises, in the case of the embodiment shown, a device 10 for conveying circuits 12 (here, for example, printed-circuit boards), from a first station 14 for preheating the boards to a device 16 for treating the boards 12 before soldering, by treatment of the latter by means of excited or unstable chemical species, and then to a wave-soldering station 18 at which the boards, carrying the electronic components to be soldered, are brought into contact with at least one wave of a solder alloy.

As may be seen in Figure 1, the conveying device 10 comprises one or more transfer belts, such as 20, illustrated by the dot-dash [sic] line in this figure, on which the printed-circuit boards 12 are placed.

Each board 12 here is provided with a number of through-holes into which the leads of the electronic components, such as 22 and 24, that have to be soldered, are inserted.

As may be seen in Figure 1, the belt 20 extends between two guide rollers, such as 26, at least one of which is a driven roller.

The boards 12, placed on the belt 20, are firstly transferred from the first, preheating station 14, at which a suitable heat-treatment device 28 is placed, then [sic] to the second fluxing station 16 at

which the boards undergo a decontamination and deoxidation operation by bringing the boards into contact with excited or unstable gaseous species.

Next, the boards thus fluxed are brought into  
5 contact with at least one solder-alloy wave 30 at the soldering station 18, which wave 30 is obtained by pumping a solder bath contained in a tank 32 through a nozzle 34.

The excited or unstable gaseous species  
10 treating the boards 12 at the fluxing station 16 are obtained here by passing a suitable initial gas, for example a reducing gas mixture containing, for example, nitrogen and hydrogen, through a device, such as 36, for forming excited or unstable chemical species by  
15 passing the initial gas through an electrical discharge.

As shown in Figure 2, each device 36 for forming excited or unstable chemical species comprises, in the case of the embodiment shown, a first tubular  
20 electrode 37, formed for example by an internal face of a metal block 38, and in which is concentrically placed an assembly formed from a tube 40 made of dielectric material, for example ceramic, on the internal face of which is deposited, by metallization, a second  
25 electrode 41 shown with an exaggerated thickness in Figure 2 in order to improve the clarity.

The dielectric tube 40 and the second electrode 41 define, together with the first electrode 37, a tubular passage 42 for the gas, and, internally, an  
30 internal volume 44 through which a refrigerant is made to flow.

The block 38 comprises two diametrically opposed longitudinal slots 46 and 48 forming respectively the inlet into the passage 42 of the  
35 initial gas to be excited and the outlet of the flow of treatment gas containing the excited or unstable gaseous species.

The slots 46 and 48 extend over the entire axial length of the cavity 42.

Moreover, the block 38 furthermore includes, advantageously, on the periphery of the first electrode 37, a plurality of ducts, such as 50, for the passage of a refrigerant, for example water.

5           Moreover, Figure 2 shows that the gas inlet slot 46 communicates with a homogenizing chamber 52 formed in a casing 54 fastened to the block 38 and having a pipe 56 for supplying the initial gas.

10           The module is completed by a high-voltage high-frequency electrical generator 58 intended to generate a discharge in the gas mixture flowing through the gas passage 42 so as to excite the gas molecules of which it is composed and thus to generate, at the outlet 48, a treatment gas mixture containing excited or unstable  
15           chemical species, but being substantially free of electrically charged species, which deoxidize and decontaminate the external surface of the printed-circuit boards 20 (Figure 1).

20           As will therefore be apparent to those skilled in the art, the boards here are in a post-discharge situation.

          Thus, each device 36 for forming excited or unstable chemical species generates, as output, a flow of gas containing chemical species emitted in a  
25           direction generally perpendicular to the surface of the boards 12 to be treated.

          As may be seen in Figures 3 and 4, the flow of gas containing the chemical species intended to ensure that the board is fluxed tend naturally to spread out  
30           so that the particles lying on the periphery of the flux tend to move in a direction approximately parallel to the surface of the board.

          As was mentioned above, this portion of the flow is less effective for treating the holes made in  
35           the board for mounting the components.

          To alleviate this drawback, and according to the invention, the excited particles are forced to propagate approximately perpendicular to the board so as to go into the holes.

To do this, the pressure, on each board 12, of the flow of gas containing the chemical species is locally increased.

More preferably, insofar as the offending  
5 particles lie on the periphery of the treatment flow, the pressure of the treatment flow is increased on the periphery of the flow.

According a first embodiment, shown in Figure 3, the pressure of the flow of activated gas is  
10 increased by using a jet of an auxiliary entrainment gas (not passing through the electrical discharge), for example nitrogen or a gas identical to that used for generating the excited particles, for example nitrogen mixed with hydrogen and, where appropriate, water  
15 vapour.

As may be seen in Figure 3, the jet of entrainment gas is generated by means of an entrainment device 60, suitable for expelling the entrainment gas, drawn from a chamber 62, in a direction approximately  
20 parallel to the axis of the holes, i.e. perpendicular to the surface to be treated, as shown by the arrows F, at a relatively high speed, for example of between 10 and 100 m/s.

The means 60 may, for example, consist of a  
25 venturi-effect knife or of a flow amplifier.

Under the action of this jet of entrainment gas, the excited or unstable particles are consequently forced to move parallel to the axis of the holes to be treated.

30 Thus, the width of the area treated by the flow of excited particles is considerably improved.

According to another embodiment, shown in Figure 4, with each board being at the fluxing station 16, in a preferably sealed chamber, the pressure of the  
35 treatment gas on the board is increased by means of at least one fan 64 facing the board and placed level with the periphery of the flow of gas so as to force the flow of treatment gas in this region to move in a direction approximately perpendicular to the board.

In this embodiment, it is intended that the entrainment gas be removed from the treatment gas present in the chamber.

5 As in the embodiment described above with reference to Figure 3, it is thus possible for the surface area treated by the flow of gas containing the excited or unstable species to be considerably increased using this entrainment device.

10 Although the present invention has been described in relation to particular embodiments, it is not in any way limited thereby but is, on the contrary, capable of modifications and of variants which will be apparent to those skilled in the art in the context of the claims hereinbelow.

15 Thus, although the invention has more particularly been exemplified in the foregoing in the context of the wave soldering of components on electronic circuits, it will be understood that it applies much more widely to many other surface  
20 treatments, whether these be surface treatments used in the fabrication of single-layer or multilayer printed circuits (descaling, cleaning, connection-hole deflashing (or desmearing) operations or else fluxing operations before tinning or any other deposition of  
25 metallic layers) and, of course, in other industries involving other types of metal surfaces.

**CLAIMS**

1. Process for the surface treatment, by dry means, of at least one metal surface portion, in which  
5 the portion is treated at a pressure close to atmospheric pressure by a flow of a treatment gas containing excited or unstable species, characterized in that the pressure of the treatment gas on the metal surface portion is increased locally so as to force the  
10 chemical species to move in a direction approximately perpendicular to the said surface.
2. Process according to Claim 1, characterized in that the excited or unstable chemical species are obtained by passing an initial gas through an  
15 electrical discharge.
3. Process according to Claim 1 or 2, characterized in that the said treatment gas is substantially free of electrically charged species.
4. Process according to Claim 3, characterized in  
20 that the said treatment gas is obtained from a primary gas mixture and, where appropriate, from an adjacent gas mixture, the said primary gas mixture being obtained at the gas outlet of at least one apparatus for forming excited or unstable gaseous species, in  
25 which an initial gas mixture comprising an inert gas and/or a reducing gas and/or an oxidizing gas has been transformed, the said adjacent mixture not having passed through the said apparatus.
5. Process according to one of Claims 1 to 4,  
30 characterized in that, since the flow of the treatment gas is emitted towards the said surface portion in a direction generally perpendicular to the latter, and since it includes, on the periphery, excited or unstable particles moving in a direction approximately  
35 tangential to the said surface portion, the pressure of the treatment gas on the said surface portion is increased on the periphery of the said flow.
6. Process according to one of Claims 1 to 5, characterized in that the pressure of the treatment gas



on the said surface portion is increased by means of at least one flow of entrainment gas injected perpendicularly to the said surface portion.

7. Process according to Claim 6, characterized in that the entrainment gas contains nitrogen.

8. Process according to one of Claims 1 to 5, characterized in that, since the said surface portion is placed in a treatment chamber, the pressure of the treatment gas on the said surface portion is increased by means of at least one fan facing the said surface so as to force the flow of treatment gas to strike the said surface portion in a direction approximately perpendicular to the latter.

9. Process according to one of Claims 1 to 8, characterized in that the said metal surface portion is present on a printed-circuit board and in that the said surface treatment carries out one or more of the following functions on the said surface: cleaning, degreasing, surface activation, deflashing, fluxing before soldering or tinning.

10. Process for the wave soldering of electronic components (22, 24) on an electronic circuit during which:

- the components (22, 24) are placed at connection points made on the circuit;

- an operation of fluxing the circuit (12) is carried out by treating the latter, at a pressure close to atmospheric pressure, by means of a flow of treatment gas, using the surface treatment process according to any one of Claims 1 to 9; and

- the circuit (12) carrying the components (22, 24) is brought into contact with a wave (30) of a solder alloy.

11. Process according to Claim 10, characterized in that, since the flow of treatment gas is emitted towards the circuit (12) in a direction generally perpendicular to the latter, and since it includes, on the periphery, excited or unstable particles moving in a direction approximately tangential to the surface of



the circuit (12), the pressure of the flow of treatment gas on the circuit (12) is increased on the periphery of the said flow.

12. Process according to either of Claims 10 and 11, characterized in that the pressure of the treatment gas on the circuit is increased by means of at least one flow of entrainment gas injected perpendicularly to the circuit.

13. Process according to Claim 12, characterized in that the entrainment gas contains nitrogen.

14. Process according to either of Claims 10 and 11, characterized in that, during the fluxing step, with the circuit being placed in a treatment chamber, the pressure of the treatment gas on the circuit is increased by means of at least one fan (64) facing the circuit so as to force the flow of treatment gas to strike the circuit (12) in a direction approximately perpendicular to the latter.

15. Process according to any one of Claims 10 to 14, characterized in that the excited or unstable chemical species are obtained by passing an initial gas through an electrical discharge.

16. Process according to any one of Claims 10 to 15, characterized in that the treatment gas containing the excited or unstable chemical species is produced from a reducing gas mixture containing nitrogen and hydrogen.

17. Process according to any one of Claims 10 to 16, characterized in that the said treatment gas is substantially free of electrically charged species.

18. Process according to Claim 17, characterized in that the said treatment gas is obtained from a primary gas mixture and, where appropriate, from an adjacent gas mixture, the said primary gas mixture being obtained at the gas outlet of at least one apparatus for forming excited or unstable gaseous species, in which an initial gas mixture containing an inert gas and/or a reducing gas and/or an oxidizing gas has been



transformed, the said adjacent mixture not having passed through the said apparatus.

19. Process according to any one of Claims 10 to 18, characterized in that the electronic circuit  
5 treated is a printed-circuit board.

20. Apparatus for treating at least one metal surface portion, by dry means, for the implementation of a process according to any one of Claims 1 to 9, characterized in that it comprises a source of  
10 treatment gas containing excited or unstable chemical species, a device for conveying parts comprising the said at least one metal surface portion, allowing the parts to be brought into contact with a flow of treatment gas, characterized in that it comprises means  
15 for locally increasing the pressure of the treatment gas on each part, so as to force the chemical species to move in a direction approximately perpendicular to the latter.

21. Apparatus for the wave soldering of electronic  
20 components (22, 24) on a printed-circuit board, for the implementation of a process according to any one of Claims 10 to 19, characterized in that it comprises a device (10) for conveying boards through at least one device (36) for fluxing the boards, by treating the  
25 latter by means of a flow of a treatment gas containing excited or unstable chemical species, the said boards (12) carrying, on at least one of their sides, the components (22, 24) to be soldered, at connection points on the latter, then through a tank (32)  
30 containing a solder alloy for the purpose of soldering the components, and in that the or each fluxing device (36) includes means (60, 62; 64) for locally increasing the pressure of the treatment gas on each board (12) so as to force the chemical species to move in a direction  
35 approximately perpendicular to the latter.

