

NOZZLE TIP**Field of the Invention**

The present invention relates generally to a nozzle
5 tip adapted for use in a fluid jet nozzle for removing
flashes in integrated circuits.

Background of the Invention

During molding process for encapsulating a
10 microelectronic die on a leadframe, the die is placed in
a cavity of a mold and a thermoset compound is injected
into the cavity. During molding, the thermoset compound
may leak onto the leads of the leadframe and undesirably
forming flashes around the leads when hardened. During
15 production, the leads are typically immersed in chemical
solutions such as potassium hydroxide solution, along
with electrolysis to loosen these flashes before being
removed. The removal of flashes which is referred herein
as de-flashing is typically carried out through
20 pressurized waterjet streams.

The pressurized waterjet streams may be provided
through a plurality of water nozzles 105, 109, 112, 115
and 118 as shown in Fig. 1. During production, the ICs
can be provided on a reeled-up strip or a leadframe 118
25 in frame to frame processing. Each strip/leadframe

contains one or more rows of ICs arranged along the length of the strip/leadframe. In the above example, the strip/leadframe contains 4 rows of ICs, 121, 125, 127 and 130. As the strip/leadframe is rolled pass the waterjet
5 device 103 in direction -X, each stream of waterjet is continuously shot at every passing lead in right angle for maximum impact.

In typical de-flashing system making use of conventional nozzles, due to the size and bulging
10 construction of the nozzles, a nozzle is typically spaced apart at about 20mm or more centre to centre from each other. With rapid technological advancement, the size of IC is shrinking and as a result, it is possible to increase the number of rows of IC within each
15 strip/leadframe such that the distance between each row of IC is reduced and thereby increasing the row density within each strip/leadframe. For example, row to row distance may range about 4mm or less in a densely packed strip/leadframe.

20 As a result, conventional nozzles used in de-flashing of dense strip/leadframe would have to be arranged further from each other and this would result in a long chain of nozzles along the assembly line. In the example as shown in Fig. 1, the strip/leadframe comprises
25 4 rows with a distance of 4 mm row to row, a de-flashing

system using conventional nozzles, with spacing requirement of at least 20 mm centre to centre from each other, would require 5 columns of 1 nozzle per column to be arranged along the assembly line as shown by columns
5 I, II, III, IV and V in Fig. 1. In an even denser strip/leadframe of 9 rows with a distance of 2mm row to row, de-flashing system using conventional nozzles would require 10 columns of 1 nozzle per column to be arranged along the assembly line.

10 Additionally, a second set of de-flashing system is required for hitting and cleaning the reverse side of the strip/leadframe. The second set would have to be installed at the opposite side of the production line and is usually installed further down the production line due
15 to space constraint. As a result, de-flashing system using conventional nozzles becomes very long and is highly undesirable, particularly in a space constraint production environment. Furthermore, as the nozzles are preferably housed within a container commonly known as a
20 manifold to modularized the nozzles for ease of handling and installation, the length of each manifold would also increase and occupy a large area of the production line.

As evidenced from the above discussion, it is desirable to provide an alternative to ameliorate one or
25 more of the abovementioned problems.

Summary of Invention

In accordance to one aspect of the present invention, there is provided a de-flashing system for removing flashes from leads of integrated circuits
5 comprising one or more fluid jet nozzles being arranged in a plurality of columns and allowing placement of one or more nozzles per column with a minimum centre to centre spacing between each nozzle within said column.

The fluid jet nozzle includes a nozzle tip being
10 housed within a cap and a body, said nozzle tip includes an inlet and an outlet, said inlet is connected to said outlet through a fluid passageway within said nozzle tip for producing an output stream of a required spread angle and width when being discharged from said outlet.

15 The passageway includes means for funneling pressurized fluid from said inlet to said outlet for minimizing turbulence.

Preferably, the minimum centre to centre spacing between each nozzle within said column is about 12 mm or
20 less.

Preferably, the nozzle tip has a diameter of 8.00 mm or less and is capable of operating on pressurized fluid of 1000 bars or more for a continuous period of at least 6 months.

Brief Description of the Drawings

Fig. 1 shows a top view of an IC
strip/leadframe and locations of water nozzles along
5 a production line;

Fig. 2a shows an exploded view of a fluid
nozzle in accordance to one embodiment of the
invention;

Fig. 2b shows a perspective view of the fluid
10 nozzle when tightened;

Fig. 3a shows a cross sectional view of a
nozzle tip in accordance to a preferred embodiment
of the invention;

Fig. 3b shows an outlet on proximal end of the
15 nozzle tip;

Fig 3c shows the tapering angle of the outlet;
and

Fig. 4 shows an arrangement of nozzles in
accordance to one embodiment of the present
20 invention in a 2 x 2 x 1 matrix.

Preferred Embodiments of the Invention

The fluid jet nozzle 200 as shown in Fig. 2a
comprises a body 206, a cap 212 and a nozzle tip 220.
25 The cap 212 is open ended with a first end 224 and a

second end 227. The first end 224 may be coupled to body 206 through for example screwing and hence securing the nozzle tip 220 in position within the cap 212 when tightened as shown in Fig. 2b. The second end 227 of cap 212 includes an opening with a diameter smaller than the diameter of nozzle tip 220. The second end 227 allows pressurized fluid stream from the nozzle tip 220 to pass through and the smaller opening end 227 prevents the nozzle tip 220 from falling out when the cap 212 is tightened to the body 206.

The body 206 comprises a distal end which provides an inlet 209 in which pressurized fluid from an external pump may be directed into the nozzle 200. The pressurized fluid is discharged through an opening 215 on the proximal end of the body 206 and is channeled into the nozzle tip 220 for conditioning. The conditioning would produce a stream of pressurized fluid of the required specifications which include, for example, required spray angle and of the required characteristics, for example, substantially laminar fluid stream. The conditioning relies on internal micro features of the nozzle tip 220 in which pressurized fluid flows therethrough to produce the required output stream. The conditioned fluid stream is discharged through an outlet 232 located at the centre of the proximal end of the nozzle tip 220.

The nozzle tip 220 further includes a means for funneling pressurized fluid from the distal end of the nozzle tip 220 into outlet 232 through a passageway within the nozzle tip. The passageway reduces the
5 turbulence of pressurized fluid flowing therethrough. It is found that when pressurized fluid flows through a narrow channel, tremendous turbulence is formed within the channel and this may easily crack the nozzle tip and reduces its life span. The funneling of the present
10 invention smoothen the flow of the pressurized fluid through the passageway and advantageously increases the life span of the nozzle tip against wear and minimizing incident of crack arising from any turbulence formed from the flow of high pressurized fluid.

15 In a preferred embodiment of the invention, the funneling means includes a funnel shaped opening 303 at the distal end of the nozzle tip 220 as shown in Fig. 3a. The funnel 303 is connected to outlet 232 through channels 307 and 312. The funnel 303 comprises an
20 opening which tapers into channel 307 at angle θ_1 . Preferably θ_1 is 90° although θ_1 may also range between 70° and 100° . Preferably, the diameter of the funnel 303 is about 45% to 65% of the diameter of nozzle tip 220.

The funnel 303 and channels 307 and 312 form a
25 narrowing passageway along the centre of nozzle tip 220

towards the outlet 232. Preferably, channel 307 narrows into channel 312 at an angle θ_2 . In a preferred embodiment, θ_2 is about 30° although θ_2 may also range between 20° and 40° . Preferably, the diameter of channel 307 and channel 312 is about 1.5 mm and 0.2 to 0.8 mm respectively while the height of channel 307 and channel 312 is about 0.5 mm and 2.5 mm respectively.

In an alternative embodiment of the invention, the channel 307 may also be replaced entirely by funnel 303 such that funnel 303 tapers into channel 312 without a need for additional channels.

In a preferred embodiment, the outlet 232 comprises an oval shaped opening although other circular shapes such as a round shape may also be used. Preferably, the length of the outlet 232 is about 0.5mm although the dimension may be varied below or above the preferred dimension, depending on design requirements.

The tip end of channel 312 is tapering at an angle θ_3 , as shown in Fig 3c, towards the outlet 232 such that a pressurized fluid stream is dispersed at θ_3 when discharged through the outlet 232. Preferably, θ_3 is between 10° and 20° to allow a dispersion of the otherwise substantially linear stream of pressurized fluid. Instead of impacting at a right angle, the stream is now dispersed at θ_3 to impact a larger area of an IC

lead. Although this may reduce the force of the stream upon impact, the loss may be compensated by increasing the fluid pressure at inlet 209 without jeopardizing the integrity of the nozzle tip 220 or the structures
5 therein. Optionally, a groove 512 may be formed across the proximal surface of the nozzle tip 220 for allowing ease of turning the nozzle tip for positioning.

As the operating pressure exerted within the nozzle tip 220 may reach beyond 1000 bars, it is preferable that
10 the nozzle tip is made from high grade steel material such as for example Steel 705M from Assab or steel under the trade mark "ELMAX" from Uddeholm for durability as well as operational reliability.

In a preferred embodiment of the invention, the
15 nozzle tip 220 comprises a diameter of about 4.99mm and a height of about 5.00mm although the dimensions may also be varied according to applications. For example, in an alternative embodiment, the nozzle tip may be machined to a diameter of 7.99 mm or less.

20 The nozzle tip 220 with a diameter of 7.99 mm in accordance to the present invention when in used in a nozzle adapted for a 7.99mm diameter nozzle tip would require only a spacing of about 12 mm centre to centre from each nozzle. As a result, the nozzle tip 220 of
25 7.99 mm diameter when in used for de-flashing a 4-row

strip/leadframe with a distance of 4 mm row to row, would require only 3 columns, with 2 nozzles per column for the first and second column, and 1 nozzle per column for the last column forming a 2 x 2 x 1 matrix as shown in Fig.

5 4. Conventional nozzles would require 5 columns of 1 nozzle per column. The nozzles may be housed within a manifold 401 to modularized the nozzles for ease of installation and handling. Each manifold 401 further includes an inlet 403 for supplying pressurized fluid to
10 other nozzles within the manifold.

In an even denser strip/leadframe comprising a 9-row strip/leadframe, the row to row distance is 2mm or less. The nozzle tip 220 based on a diameter of 4.99 mm in accordance to the present invention, when in used in a
15 nozzle adapted for a 4.99mm diameter nozzle tip, would require only a spacing of about 10 mm centre to centre from each nozzle. As a result, the configuration based on the present invention would require only 5 columns of 2 nozzles per column forming a 2 x 2 x 2 x 2 x 2 matrix.
20 Conventional nozzles would require 10 columns of 1 nozzle per column to achieve the same results.

The nozzle tip 220 in accordance to the present invention further allows the same de-flashing system to be used for 2 different types of IC layout without a need
25 for changing the manifold as long as the pitch between

each row of IC remains the same. The dispersion of pressurized fluid streams at a wider angle from the outlet 232 of the nozzle tip 220 allows the fluid stream to hit and cover a wider area of a lead. Essentially, the
5 leads of ICs of different layouts would still be effectively de-flashed. This advantageously eliminates down time as a result of stopping production for switching and installation of manifold of a different configuration.

10 In a preferred embodiment of the invention, the distal surface of nozzle tip 220 and the proximal surface of the body 206 contacting the distal surface of nozzle tip 220 when tightened, are flattened through for example, commonly known lapping process to provide a flat
15 surface finishing. To achieve even higher flatness surface finishing, the surfaces may be polished to smoothen and streamline their microscopic surfaces through for example, commonly known electro-polishing method. Alternatively, the surfaces may also be polished
20 using fine grit grinding paper. The polished surfaces advantageously allow the nozzle tip 220 to be fitted and tightened to body 206 within cap 212 without a need for seals or washers. A seal or washer free coupling is useful to reduce weak links within the multi-parts nozzle

during high pressure operations and to eliminate a need for replacement or maintenance.

While the invention has been particularly shown and described with reference to various embodiments, it will
5 be recognized by those skilled in the art that modifications and changes may be made to the present invention without departing from the spirit and scope thereof. The scope of the invention should therefore be determined not with reference to the above description
10 but with reference to the appended claims along with their full scope of equivalents.

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What is claimed is:

1. A pressurized fluid jet nozzle for removing
 flashes from leads of integrated circuits
5 comprising:
 a nozzle tip being housed within a cap and a
 body, said nozzle tip includes an inlet and an
 outlet, said inlet is connected to said outlet
 through a fluid passageway within said nozzle tip
10 for producing an output stream of a required
 characteristic when being discharged from said
 outlet;
 wherein said passageway includes means for
 funneling pressurized fluid from inlet to outlet for
15 minimizing turbulence.
2. The fluid jet nozzle as claimed in claim 1, wherein
 said means for funneling includes a funnel and one
 or more channels that narrow into said outlet, said
20 one or more channels direct pressurized fluid from
 said funnel into said outlet with minimum fluid
 turbulence.
3. The fluid jet nozzle as claimed in claim 1 or claim
25 2, further includes a plurality of fluid jet nozzles

being arranged for use in a production line to allow an arrangement of one or more nozzles per column with a centre to centre spacing of 12 mm or less between each nozzle within said column.

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4. The fluid jet nozzle as claimed in claim 3 wherein said plurality of fluid jet nozzles are arranged within a manifold.

10 5. The fluid jet nozzle as claimed in any preceding claim, wherein said outlet of nozzle tip has a length of about 0.5mm or less.

6. The fluid jet nozzle as claimed in any preceding
15 claim, wherein said nozzle tip has a diameter of about 8.00 mm or less.

7. The fluid jet nozzle as claimed in any preceding claim, wherein said outlet of nozzle tip comprises a
20 rounded shape.

8. The fluid jet nozzle as claimed in claim 7, wherein said outlet of nozzle tip comprises an oval shape.

9. The fluid jet nozzle as claimed in any preceding claim, wherein said outlet of nozzle tip includes an opening that tapers at an angle of about 30° or less into the outlet.

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10. The fluid jet nozzle as claimed in any preceding claim, wherein said nozzle tip is adapted for operating pressure of 1000 bars or more for a continuous period of at least 6 months.

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11. The fluid jet nozzle as claimed in any preceding claim, wherein said fluid for use in said nozzle includes water.

- 15 12. The fluid jet nozzle as claimed in claim 2, wherein said funnel has a diameter of about 45 to 65% of the diameter of said nozzle tip.

13. The fluid jet nozzle as claimed in claim 1, wherein
20 said nozzle tip is adapted for seal free coupling to said body when tightened within said cap.

14. A de-flashing system for removing flashes from leads of integrated circuits comprising one or more
25 fluid jet nozzles being arranged in a plurality of

columns and allowing placement of one or more
nozzles per column with a minimum centre to centre
spacing between each nozzle within said column;

wherein said fluid jet nozzle includes a nozzle
5 tip being housed within a cap and a body, said
nozzle tip includes an inlet and an outlet, said
inlet is connected to said outlet through a fluid
passageway within said nozzle tip for producing an
output stream of a required characteristic when
10 being discharged from said outlet; and

wherein said passageway includes means for
funneling pressurized fluid from said inlet to said
outlet for minimizing turbulence.

15 15. The de-flashing system as claimed in claim 14,
wherein said minimum centre to centre spacing
between each nozzle within said column is about 12
mm or less.

20 16. The de-flashing system as claimed in claim 14 or
claims 15, wherein said nozzle tip has a diameter of
8.00 mm or less.

17. The de-flashing system as claimed in any of claims
25 14 to 16, wherein said nozzle tip is adapted for

operating pressure of 1000 bars or more for a continuous period of at least 6 months.

18. The de-flashing system as claimed in claim 14,
5 wherein said nozzle tip is adapted for seal free coupling to said body when tightened within said cap.

19. The de-flashing system as claimed in claim 14,
10 wherein said characteristic of an output stream includes spread angle and width of said output stream.

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