Development of Local Flux Application Method

Hisaki HAYASHI
Yasuyuki WATANABE

Abstract

In recent years, the high-density parts mounting method for printed circuit boards has been rapidly increasing, and the mounting method for leadless parts has been replaced with a reflow soldering method. However the remaining lead parts for through-hole adopt flux application / flow soldering for local mounting areas.

There are four types of local flux application methods such as spray type / drop jet type / ultrasonic type / foaming type, and each method has advantages and disadvantages in terms of influence on part or productivity etc.

While taking advantage of foaming type that it can apply flux to parts without attachment of flux (it means no influence on part), we have developed a new flux application method to overcome the disadvantages which are the poor local application performance and the difficulty of flux control. We would like to introduce the content of this new flux application method.

1 Introduction

In recent years, the density of parts mounting to Printed Circuit Board (hereinafter referred to as PCB) has been rapidly increasing, and mounting method for leadless parts has been replaced to a reflow soldering method because a flow method, which applies flux to entire surface of a PCB and solders it collectively, has possible defect such as solder bridges*(1) etc., which cannot be solved.

Then other lead parts for through-hole*(2) need to be soldered by local flow soldering, so that spray type flux application (hereinafter referred to as spray type) method is mainly used (**Fig. 1**) because of its easy applying of flux.

However, because spray type applies flux in a mist state with high pressure, for special parts with a contact, flux may invade inside of the parts and cause continuity failure. (**Fig. 2**)

FUJITSU TEN prepares a special jig or solders manually without flux application for the parts with flux invasion risk. Thus this becomes a heavy burden on production and productivity.

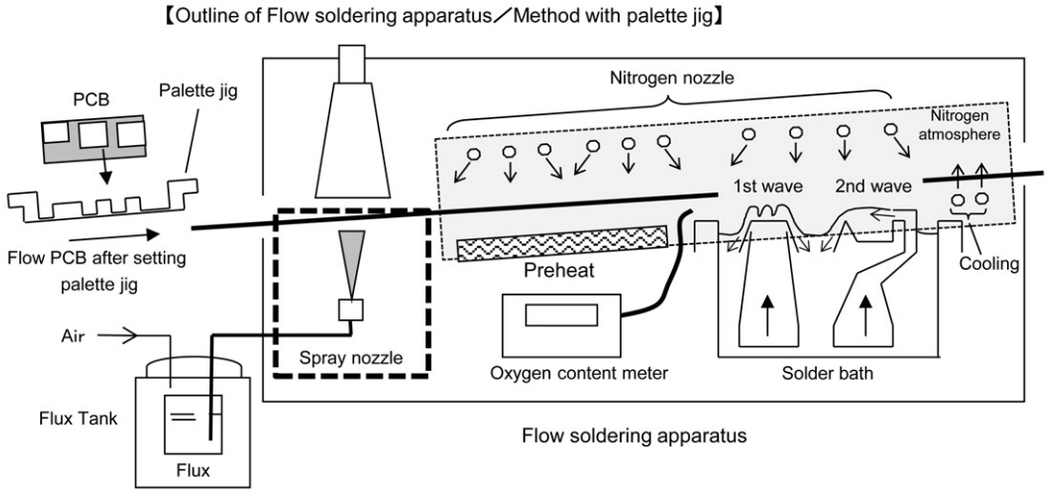


Fig. 1 Flow Soldering Process and Role of Flux

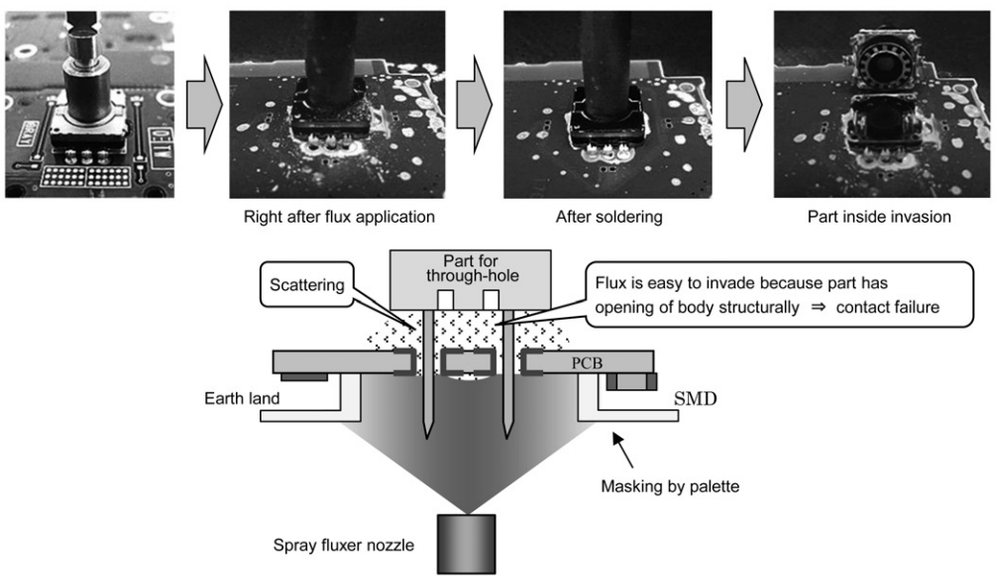


Fig. 2 Part Inside Invasion by Spray Type Flux

*(1) Electrical short state due to solder which attaches between leads

*(2) lead part which is installed to through-hole of PCB and is soldered.

2 Type of Flux Application Method

There are mainly four types of flux application methods. (**Table 1**)

【Spray type】

Spray type is the most commonly used method. Flux is pressurized in a pressurization tank and it is sent to a spray nozzle by pressure, and applied from nose of the nozzle in a mist state. The structure of this method is simple and it is inexpensive, but flux is scattered around or attached to the parts via through-hole because flux is roundly sprayed with high pressure.

【Drop jet type】

In this method, flux is pressurized in a pressurization tank, and applied to each through-hole at a pinpoint by changing the sprayed flux particle size which is controlled by opening period and cycle of valve in nozzle. The advantage of this method is a pinpoint application, but it takes long C/T (Cycle Time) because it needs to overcoat many times toward wide area. Moreover exhaust hole of nozzle is so easy to be clogged by solidified flux during idling cycle because this is intermittent application, which causes more frequent maintenance.

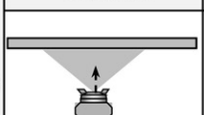
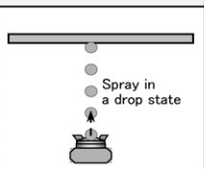
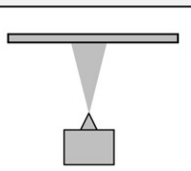
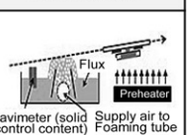
【Ultrasonic type】

This type sprays flux from nozzle, which is turned into a spray by ultrasonic transducer. After turned into a spray by ultrasonic nozzle, flux is sprayed by using of jet-air. The atomized flux by ultrasonic has an advantage that flux consumption is able to be reduced due to thin application of flux on a PCB, however the price of apparatus is high and the frequency of maintenance is high as drop jet type because of clogging of nozzle..

【Foaming type】

In this type, compressed air is supplied into a porous (having a large number of minute vents) cylinder (hereinafter referred to as foaming tube) soaked in a flux bath, and spreads as bubbles in the flux bath, and then they make flux foamed. After collecting foamed flux with the widely opened nozzle, it is guided to work conveyor line and applied to a PCB. This method has simple structure and inexpensive, but difference from other method is reuse of flux which was used for applying already. Therefore flux control (specific gravity, moisture absorption, and metal invasion etc.) is important. And handling of flux becomes complicated because height control of foamed flux

Table 1 Type of Flux Application Method

	Spray type	Drop jet type	Ultrasonic type	Foaming type
Flux application method (cross-sectional view)				
Standard application Diameter	φ 30 ~40	φ 3	–	–
Application area	Wide range	Local	Local	All
Local application	△(Masking)	◎	◎	×
Scattering to around	×	○	○	○
Feature	Possible to apply evenly in wide range	application is sprayed periodically in a drop state	Apply flux in a mist state with ultrasonic transducer. Small consumption of flux	Simple structure and possible to apply evenly in wide range
Moisture absorption control	No need	No need	No need	Need
Concentration control	No need	No need	No need	Need

is needed to contact flux and a PCB.

There are advantages and disadvantages for the above application method. We have found foaming type has the big advantage which other methods don't have that it can apply flux to parts without attachment of invaded flux.

We have addressed to develop new flux application method on the basis of foaming type to improve the poor local application performance and to overcome the difficulty of flux control, which are disadvantages of this method.

3 Challenges of Foaming Type

【Local application performance】

As foaming type applies flux by contacting foaming flux and PCB, application area of flux is a PCB overall, hence it is difficult to locally apply flux. (**Fig. 3**)

For local application, there are some application methods, such as to apply only to the local area which contacts flux after masking of PCB, to mask foaming part of foaming tube, and so on. But those methods are not positively adapted to mass production due to cost and operation control.

【Flux control】

A foaming fluxer blows out air in flux solution from a large number of minute vents, and generates bubbles of flux then applies the bubbles to a PCB. Flux which is not applied to the PCB returns to a flux bath through the outside of nozzle. It is recycling type.

Therefore, IPA (Isopropyl Alcohol) which is diluent of flux, vaporizes with time of use, then specific gravity of flux in flux solution changes. (specific gravity becomes heavy by the solid content*(3) which relatively increases by IPA volatility) (**Fig. 4**) And there are other problems such as the increase of moisture content by moisture absorption because of open-air type, metal invasion from the PCB and so on.

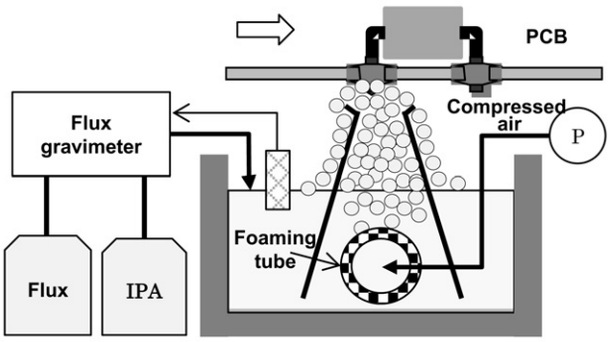


Fig. 3 Outline of Foaming Type Fluxer

Therefore the control is complicated because complement of flux and IPA or replacing whole amount is needed based on the result of periodical measurement of specific gravity and moisture content.

In order to reduce the complexity, there is a system with an automatic compensation function to replenish the flux bath with flux and IPA as required in order to keep specific gravity in the bath constant which is measured by gravimeter, but it is very expensive. (Fig. 3)

The change of specific gravity of flux greatly affects foaming condition. If specific gravity is light, the height of foaming is high, on the contrary, if it is heavy, the height of foaming is low. Specific gravity of flux is 0.81 to 0.83, but it becomes heavy nominally by moisture absorption, because specific gravity of water is 1. Even if an automatic compensation system which replenishes with IPA is introduced, periodical manual adjustment of compressed air to the foaming tube is needed so as to maintain a certain height.

*(3) Resin such as resin pine-tree gum which melts into flux

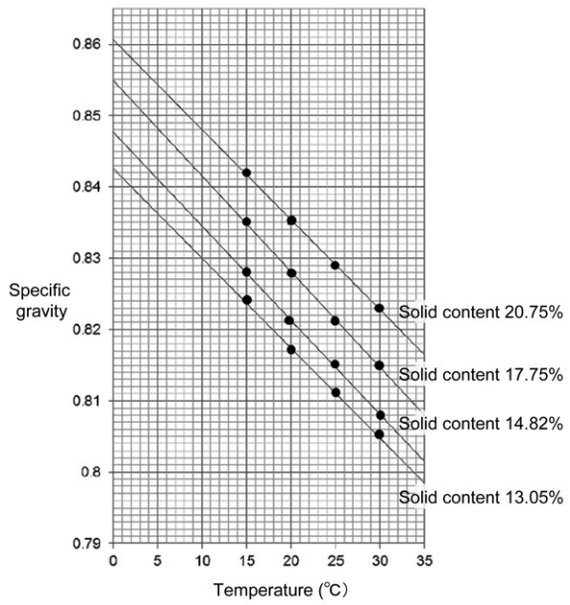


Fig. 4 Relations of Solid Content and Specific Gravity (Example)

4 Development of Local Foaming Fluxer

【Developmental target】

We have started development with the following targets.

(1) Local application is possible by foaming type.
(2) Flux control is easy.
(3) Maintenance is easy.

It is desirable that local application of flux is capable even to one lead part. It makes local application possible to blow out foamed bubble from a cylindrical pencil type nozzle like local jet type soldering apparatus. **(Fig. 5)**

But in foamed flux, bubbles are overlapping each other, so that foamed flux simply sent to the pencil type nozzle is exploded due to its own weight in nozzle. Therefore it was difficult to guide flux stably to the head of nozzle.

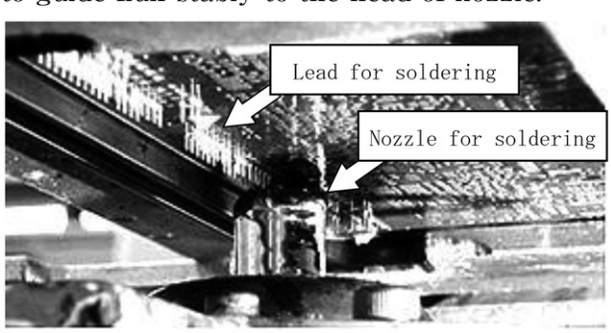


Fig. 5 Local Jet Type Soldering Apparatus

We performed development with new idea, foaming flux near the head of the pencil type nozzle instead of sending foamed flux in the flux bath.

As for the method of foaming in nozzle, the idea of foaming flux in the nozzle by mixing air and flux is materialized as a hint of a water-saving shower head which is a device for spouting water by mixing air and water. Thus we have succeeded to spout foamed flux from the nozzle stably. **(Fig. 6)**

Fig. 6 Nozzle of Local Foaming Type Flux

This method has the feature which conventional methods don't have.

①A big flux bath is not necessary as conventional one because flux is formed in the nozzle, and it is possible to apply flux to any position by moving the nozzle by robot.
②Flux is in a shielded and separated small tank. It is supplied to the nozzle and foamed only by required amount only when needed. On this account, flux is not always exposed to the air, so that moisture absorption from air and vaporization of IPA are reduced and change of specific gravity of flux is small.
③Because of the structure that foaming tube doesn't always soak in flux solution, foreign material is hard to attach to foaming tube and to clog. As a result, the maintenance performance of foaming tube is improved.

As explained above, we have achieved the targeted local application by adopting foaming type with which flux can be applied even to one lead part. **(Fig. 7)**.

Regarding complicated flux control with gravimeter, we have decided not to use specific gravity control by fully changing flux every

day and by supplying flux to small tank, of which quantity corresponds to flux consumption.

Conventional maintenance was large-scale such as cleaning a foaming tube extracted from a big flux bath after collecting flux. However periodically cleaning the nozzle after being removed from the apparatus is about all the maintenance for the local foaming type which we newly-developed. As a result, we realized to reduce the frequency of the maintenance and man-hour. (**Fig. 8**)

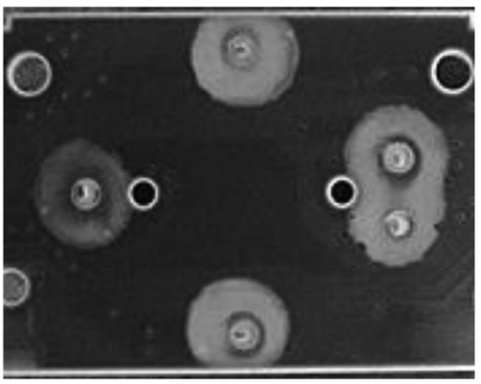


Fig. 7 Example of Application with Local Foaming Type Fluxer

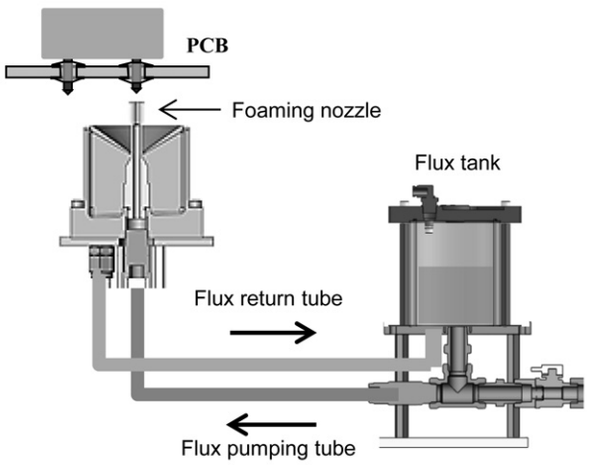


Fig. 8 Outline of Local Foaming Type Fluxer System

5 Conclusion

Through this development we achieved new flux application method, "foaming type local application", which is not in the market.

This method is gentle to parts and can apply flux at a pinpoint. Therefore this method is widely expected to apply flux not only to the area which spray type cannot be used but also to the terminal of power-oriented parts or the like with poor solderability because of its uniform application characteristic into the through-hole.

Finally, there are many technologies that were superior in the past even if it is not used now. Why are they not used? If the reasons could be investigated and resolved, we might be able to utilize them enough even now. "Developing new ideas based on study of the past", we would like to contribute developing manufacturing capability by utilizing well the achievements left behind by our senior engineers.

Profiles of Writers

Hisaki HAYASHI
Production Grp
)Production Engineering Dept

Yasuyuki WATANABE
Production Grp
)Production Engineering Dept