Suggested Methods of Reducing Soldering Void Rate of Power Devices, without Vacuum Process or with Vacuum Process

Preface

We have seen many power devices process engineers working hard in a sweat for adjusting the reflow profile to make void rate lower than 2% but sometimes all the efforts are in vain. In fact, high void rate is caused by many factors, such as insufficient soaking time, or insufficient reflow peak temperature or the surface of the lead frame is not clean or not flat, or the environment is not clean enough, all of these factors will influence the void rate. To tackle the void rate issue, we will propose two solutions, the first one is the traditional method without using vacuum reflow process and the second one is to apply the vacuum reflow process to reduce void rate, with details as follows:

A. Traditional method, without vacuum reflow process.
   1. Raising the Peak Temp of reflow process
      The maximum resistance temperature of power device is 390°C, and the peak temp of reflow process will be set higher than melting point of solder paste by 30~50°C, the higher the temperature the lower the void rate. By doing so, we can usually reduce void rate to less than 3%, or even to 1%.
   2. Extending the melting time span of solder paste (with temperature set higher than the melting point)
      Normally, melting time span is 40 seconds or above, and which can be extended to 120 seconds. (Extending the cycle time length will provide more than enough time to melt the solder)
   3. Giving uniformity dispensing volume
      The dispensed solder paste usually occupied the surface of pad about 70%, but the deviation of air type dispensing is about 15%~25%, and such deviation is the main cause of unstable void rate. To solve the unstable soldering volume problem, there are three suggested methods to dispense solder on the soldering position, with details as follows:
      I. Air type or screw type dispensing system
         Using the solder paste of Type 3~6, the screw dispenser can produce higher consistency solder paste volume. We can dispense 4 dots at one time (diameter for each dot has to be bigger than 0.7 mm), the uniformity of solder dot can be controlled within 15%. It’s a good solution to dispense the solder on die top, and also easy for maintenance.
      II. Pin transfer
         The pin transfer dispensing method could give high throughput, with UPH>90k (Die size<60 mil), and can transfer hundreds of solder at one time, and considered as one the best solution for small die. Furthermore, using pin transfer for epoxy or flux can reach excellent uniformity and get high throughput.
      III. Stencil printing
         Stencil printing is probably the best way for soldering process. 3S Silicon Tech Inc. has been integrating the Stencil printing equipment with Die bonder to make an in-line automatic machine, including automatic cleaning function of stencil. For now, tens of customers have used this in-line machine, for mass
production, resulting in an excellent performance of low void rate and avoiding die tilt after reflow.

For all the above suggested methods, we have to remind that the position and the size of solder need to be checked by AOI system. If it’s out of specification, the machine alarm will be initiated and the operator or the engineer has to decide to go or no to go. Dispensing is the most important part of die soldering process and also constitutes the major causes of products reliability failure.

4. Decreasing the oxygen content in the oven: we usually use the reflow oven with pure N2 as environment gas, and the average oxygen content should be kept lower than 100ppm.

If you have tried the foregoing methods, and still cannot have void rate reached the requirement level, we’ll suggest using vacuum reflow oven to solve the problem.

You may ask that how the void is formed, views are some people thinks that the void formed naturally, and can’t be exhausted because of the atmospheric pressure, but 3S Silicon thinks that the void is covered by flux and form flux void. However, whatever the causes might it be, high void rate impact directly of the heat dissipation and the electrical conductivity, and must be avoided as much as possible. Especially that the Flux is acidic and corrosive. Although there is cleaning process after reflow, but we can’t remove flux covered by solder. If there are flux voids left inside the package, they will affect adversely the reliability of products. To remove the flux voids, in the past, 3S will try desperately as above suggested methods. But now, with application of innovative in-line vacuum reflow oven, we can exactly let go off of all flux void through vacuum reflow process, and make the void rate reduced to low than 2%.

B. Innovative method, using Vacuum Reflow Oven to reduce void rate.

With an eager expectations of our clients, 3S Silicon launched the first vacuum reflow oven in 2013. We than started to carry out the intense product verification process, a big volume of process data was thus collected and analyzed. With those valuable data, we have had made tremendous improvement to make vacuum oven reliable, flexible and intelligent. In 2015, 3S launched the 2nd generation in-line vacuum oven. Lots of international customers are highly interested in this oven’s capability to solve their protracted void rate problem. With our open lab, these customers have tested many type of attached die in different package to see if our vacuum reflow oven can really reduce products soldering void rate, and the results were quite encouraging to almost all the customers. With chip size smaller than 10mm X 10mm, all products’ void rate are reduced to less than 2%.

Nowadays, 3S silicon’s Vacuum Reflow Oven has been adopted by many IDM and packaging companies, particularly in automobile electronics field, as a standard reflow equipment solution. Based on customer’s requirements, we can make various customized automatic in-line production machine. Incorporating stencil printer, die bonder and clip bonder, with the state-of-art vacuum reflow oven, we are sure that the customer will have a high throughput production line with good reliability and trouble-free low void rate products.
Profile of using snap reflow oven, see figure below:

- **Machine:** 3S Vacuum Reflow Oven
- **Solder Paste:** Pb92.5Sn5Ag2.5/ Type 3
- **Temp. profile:**

```
<table>
<thead>
<tr>
<th>Temp. (°C)</th>
<th>Vacuum (torr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>150</td>
<td>0</td>
</tr>
<tr>
<td>200</td>
<td>0</td>
</tr>
<tr>
<td>250</td>
<td>0</td>
</tr>
<tr>
<td>300</td>
<td>0</td>
</tr>
<tr>
<td>350</td>
<td>0</td>
</tr>
<tr>
<td>400</td>
<td>0</td>
</tr>
</tbody>
</table>

Peak Temp. >100°C

Copywriter: James Huang, President, 3S Silicon Tech., Inc.
TEL: 886-912535392 / 886-3-5577668 Ext. 100
Email: james.huang@sss-tech.com.tw
Address: No.169-2, Sec. 1, Kangle Rd., Xinfeng Township, Hsinchu County 304, Taiwan