Packaged and Wafer Level Semiconductor Failure Analysis (SJK2-14)

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Project Overview

Introduction
Today, electronic devices and humans have become inseparable, and electronic devices make humans' lives more convenient. To construct a powerful and multifunctional device, an integrated circuit (IC) chip is indispensable. In the semiconductor industry, failure analysis is an important process, which ensures high yields of semiconductor devices from the manufacturing process by finding the defects when an IC fails in the testing phase or in service. It has to provide an effective way to identify the defects within a short time, so that an IC can be modified by understanding the nature and cause of the failure. Liquid crystal thermal analysis is widely used in detecting defects on a failed IC chip or wafer by using the property of liquid crystal. Face lapping is the process that extracts the circuit layout of an IC chip by polishing and planarizing its surface to do reverse engineering.

Aim and Objective
For Liquid Crystal Thermal Analysis:
- Provide a clear way to identify the location of defects.
- Give a high efficiency in exercising the LC thermal analysis with using heater mat.
- For Face Lapping:
- Improve the quality of layout extraction in Face Lapping by using diamond film.

Methodology

Liquid Crystal Thermal Analysis
In order to detect the defect area easily by applying lower input voltage to an IC, a heater mat is used as an external heat source to shorten the difference between the ambient temperature of the liquid crystal and its transition temperature. Before exercising liquid crystal thermal analysis, it needs to measure the heat transfer efficiency of the heater mat by thermal couple.

Face Lapping
In order to provide a better quality of layout extraction, a 1 micron diamond lapping film is used. The following experiments examined the flatness of the IC chip's surface with different linear velocity.

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Type</th>
<th>Linear Velocity (m/s)</th>
<th>RPM</th>
<th>Thickness (um)</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exp.1</td>
<td>Bare</td>
<td>5.00</td>
<td>30</td>
<td>3</td>
<td>Result 1</td>
</tr>
<tr>
<td>Exp.2</td>
<td>Bare</td>
<td>5.18</td>
<td>50</td>
<td>3</td>
<td>Result 2</td>
</tr>
<tr>
<td>Exp.3</td>
<td>Bare</td>
<td>5.60</td>
<td>80</td>
<td>3</td>
<td>Result 3</td>
</tr>
<tr>
<td>Exp.4</td>
<td>Bare</td>
<td>6.00</td>
<td>100</td>
<td>3</td>
<td>Result 4</td>
</tr>
</tbody>
</table>

Results

Liquid Crystal Thermal Analysis
A table has been compiled based on the measurement. It is for predicting the heating time which needs to raise the LC's temperature to the required temperature. At the result, reducing the difference between the LC's temperature and its transition temperature, the power applied to the IC can be minimized (typically 8mW, different from which IC is used). It reduces the opportunity of the creation of other failures by applying excessive power. Compare heater mat with heat-gun, using heater mat as an external heat source, the defect area can be distinguished with a clear image by applying small amount of input voltage to an IC.

Conclusion

Using a heater mat as an external heat source can provide an effective way in raising the IC's temperature without affecting other factors such as the prevention of moving the probe tips and a clear view of LC during observing the defects. It can also keep the LC temperature just below the transition temperature for a while to allow analysts to observe the defect by applying the lowest voltage possible. Analysts can follow the created reference table to estimate the time of raising the temperature, and it gives strong support to analysts who now do not need to be always look at the microscope when preheating.

Face Lapping
Compare with slurry, using diamond film in lapping process, a high completeness surface can be extracted, especially for the bond pads and via is totally removed. However, as this approach cannot provide a 100% even layout, it can be collapsed with the micrographs which captured by the camera every time (such as every 1 min) to make a complete layout.