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Development of test panel for measurement of temperature in chamber

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Abstract

Recently, semiconductor processes utilize a lithography process to form fine patterns and copper pillars. The lithography process is a process that requires PR (Photoresist) coating. PR is made up of PR ink and solvent and maintains a certain viscosity. After coating, the PR solvent is evaporated through the bake process. The bake process is a process in which PR-coated wafers and panels are heated using a high-temperature heater within a chamber. In the bake process, it is important to keep the wafer and panel at a uniformly high temperature to evaporate the solvent. Multiple temperature sensors are placed within the chamber to maintain a high temperature environment. However, it is difficult to confirm whether uniform temperature is maintained in the actual wafer and panel. For this reason, this study developed a test panel to measure the temperature of the target in the chamber. A panel substrate that is robust to high temperatures was selected and a calibrated temperature sensor was placed at several positions. Through electrical connection, we confirmed that the temperature was measured with high repeatability from the temperature sensor.

Test, Panel, Temperature, Chamber

1. Introduction

As semiconductors become smaller, complex and diverse devices must be connected within the same space, and next-generation package technology that can integrate devices at high density at low cost is required. As the number of devices in one package increases, there are limits to integrating devices on a 1D plane. Therefore, chiplet packages that integrate devices in 2.5D and 3D within a limited space are required.

Tall Cu pillars are required for high-density vertical interfaces in 2.5D and 3D integrated packaging. To manufacture a tall Cu pillar, a pillar mold is required. Pillar molds are manufactured through the photolithography process. The photolithography process is a process that forms a pattern by coating PR (Photoresist) and then applying light. A PR mold can be produced through etching process. The photolithography process requires a PR coating process. Generally, wafers are coated with PR through spin coating. Recently, PLP (Panel level Package) is being required to improve yield. To perform spin coating on a panel, the spinner size becomes larger and PR consumption increases. To solve this problem, Inkjet based PR coating was proposed by using PR ink. To make PR ink, solvent is combined with PR. Since PR ink is a mixture of PR and solvent, a baking process to evaporate the solvent after inkjet coating is required to form the final PR layer. In response to PLP, a heater and chamber for the panel were manufactured to evaporate the PR solvent coated on the panel. In this panel baking process, in order to form a PR mold with a constant thickness, a uniform temperature must be maintained in the panel. To achieve this, it is necessary to check whether the temperature of the glass panel rises uniformly during the baking process.

In this study, we designed a test panel that can perform temperature tests at high temperatures instead of actual process panels. Considering the baking chamber, we designed a PCB board suitable for high temperatures and designed a circuit to process and monitor temperature data signals.

2. Heat Chamber

The target size of the glass panel in this study is 650x650 mm^2. In the bake chamber, the heater must be large enough compared to the glass panel to allow the glass panel to rise in temperature uniformly. The size of the heater is 800x800mm^2. Proximity pins were placed on the hot plate to prevent direct contact between the heater and the glass panel and to maintain a certain distance so that uniform heat can be applied to the glass panel. Since the glass panel on top of the proximity pin may sag and affect the uniformity of the PR after the baking process, multiple proximity pins were placed. Figure 1 shows the heater and glass panel.

Figure 1. Heater and glass panel for bake chamber

The bake chamber has a heater inside, as shown in Figure 2. A glass panel is on top of the heater. When the chamber is sealed and the heater temperature rises, it is difficult to measure the temperature of the glass panel by the heater. Therefore, we plan to develop a test panel of the same size as the glass and measure the temperature of the glass panel heated by a heater.

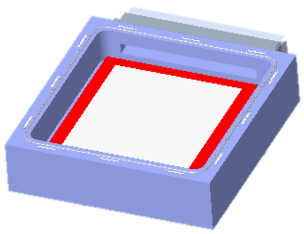

Figure 2. Bake chamber for baking process

3. Concept Design of Test Panel

The test panel can measure temperature at high temperatures, and it is necessary to select a sensor applicable to the PCB board to be manufactured in panel form. In this study, we will consider and apply two sensors.

The SMD Type PCB mount type temperature sensor was selected as PTS 1206 sensor, a Platinum Thin Film Chip Resistor . This sensor is a small temperature sensor measuring 3.2mm wide and 1.6mm tall. The temperature range is from -55 ℃ to +150 ℃. It is an ultra-small sensor that can be attached to a PCB and can be used to measure temperature distribution.

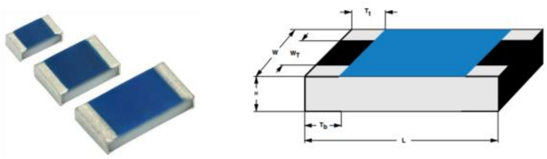

Figure 3. Platinum thin film chip resistor sensor

The TMP126 IC-based digital temperature sensor was selected as a temperature sensor for heater testing to ensure temperature accuracy through digital temperature measurement. The temperature range of this sensor is from -55 ℃ to +175 ℃, and it is a sensor that measures digital temperature through the SPI protocol.

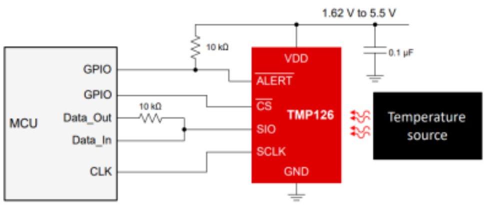

Figure 4. TMP126 IC temperature sensor interface

Based on the TMP126 IC, we designed a PCB for measuring temperature distribution through a 3x3 temperature sensor arrangement with a size of 650x650mm². Each temperature sensor requires 3 strands of wire for the SPI protocol, and 2 strands of power positive and negative power wires are required in common, so a total of 29 strands of wire are required. It was designed with a microprocessor that can operate at 150 ℃ installed inside the high-temperature PCB.

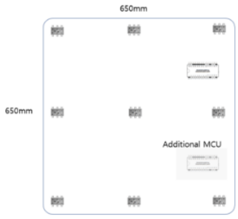

Figure 5. PCB design for 3x3 array temperature distribution measurement

4. Electric Circuit

The sensor to be applied in this study requires sensor data processing through signal processing, and the signal processing method is different for each sensor. Platinum Thin Film Chip Resistor sensor converts the change in resistance value according to the temperature of the sensor into voltage through a Wheatstone bridge circuit. Design a circuit that amplifies the signal to a range where the ADC module can read the voltage value and delivers the signal to the anode and cathode of the ADC module.

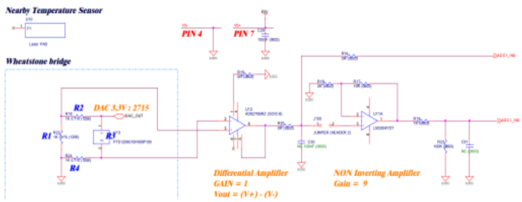

Figure 6. Designed amplifier circuit

We designed a processing module to transmit data to a PC based on a microprocessor (STM32F103). A 16-bit 4-channel ADC module with an input range of ±10V was selected and designed to connect the MSFK3.2 sensor and Platinum Thin Film Chip Resistor sensor so that the digital signal can be used as a resource for the visualization program.

5. Conclusion

In this study, we designed a test panel that can perform temperature tests at high temperatures instead of panels for actual processes during the panel bake process. We designed the PCB board considering the size and maximum temperature of the baking chamber and designed the circuit to process and monitor temperature data signals.

In the future, we plan to apply the test panel to an actual chamber to test the temperature distribution of the panel and improve it so that it can be applied to the actual process.

Acknowledgement

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