euspen's 25th International Conference & Exhibition, Zaragoza, ES, June 2025
www.euspen.eu

Design of chamber system for PR solvent baking process

Jaehyun Park[1], Cheonkyu Lee[2], Seungtaek Kim[1#]

[1] *Industrial Transformation Technology Department, Korea Institute of Industrial Technology, Republic of Korea*
[2] *Industrial Energy R&D Department, Korea Institute of Industrial Technology, Republic of Korea*

[#]*Corresponding Author / E-mail : stkim@kitech.re.kr*

Abstract

In recent semiconductor processes, tall Cu pillars of several hundred-micrometers in height are required for interconnect between packages. Tall Cu pillars can be manufactured through a semiconductor lithography process. The semiconductor lithography process requires a process of coating a thick PR (Photoresist) layer to manufacture a high aspect ratio Cu pillar. In addition, panel level packages as well as wafer level packages are recently required. Therefore, a new process of coating and baking the PR layer at the panel level is required. PR for coating is mixed high viscosity PR ink with solvent to maintain a low viscosity. After coating, the PR solvent is evaporated through a baking process. The baking process is a process of heating the PR-coated wafer and panel through a high temperature heater, and a chamber is required. The chamber includes a lift pin that transports the panel and a proximity pin that supports the panel during the process. If the panel has large deformation when transporting and supporting the coated panel, the coating uniformity decreases after the baking process. For this reason, the placement and design of the lift pin and proximity pin are important. In this study, the chamber design was conducted based on the design of the elements within the chamber.

Coating, Deformation, Process, Simulation

1. Introduction

As semiconductors become more miniaturized, complex and various devices must be connected within the same space, and next-generation package technology that can integrate devices at high density and at low cost is 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. The pillar mold is manufactured through a photolithography process. A PR coating process is required for the photolithography process. Typically, PR is coated on wafers through spin coating. However, PLP (Panel level Package) is required to improve yield in recently. When performing spin coating on a panel, the spinner size increases and PR consumption increases. To solve this problem, inkjet-based PR coating using PR ink has been proposed. In order to make PR ink, a 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. A chamber for the panel is required to evaporate the PR solvent coated on the panel. The key component in the chamber is the hot plate. In order to make a PR mold with a certain thickness in this panel baking process, the deformation of the glass substrate must be small. It is necessary to check the deformation of the glass panel during supporting and transporting the glass panel in desgin process. In this research, hot plate and lift system was designed and manufactured to make chamber for the baking process.

2. Design of chamber system

For the baking process, a hot plate is required to make a high-temperature environment. Proximity pins are also required to maintain a certain distance between the glass panel and the hot plate.

2.1. Hot plate

The target glass panel size in this study is $650x650mm^2$, and the corresponding hot plate size was selected as $800x800mm^2$.

2.2. Proximity pin

The hot plate and glass panel should be prevented from direct contact during the process. In addition, a certain distance should be maintained between the hot plate and the glass panel so that uniform heat can be applied to the glass panel. For this purpose, proximity pins were placed on the hot plate.
Glass panels placed on top of proximity pins may be deformed. If the process is carried out in a deformed state, thickness uniformity deteriorates. For this reason, multiple proximity pins are required on the hot plate.

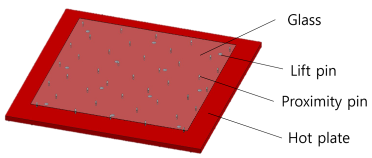

Figure 1. Hot plate and Proximity pins

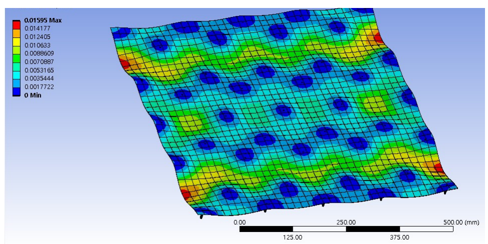

Figure 2. Deformation simulation result of Glass on the proximity pins

The permissible deformation of the glass panel during the baking process is less than 20 micrometers. During the simulation, the deformation of the glass panel due to the proximity pin is a maximum of 0.016 mm and is within the allowable deformation range.

2.3. Chamber

The outer wall of the chamber surrounds the hot plate and requires maximum heat insulation from the outside. In addition, it is configured with an inlet to receive a glass panel from the outside and an upper cover for maintenance to minimize heat dissipation.

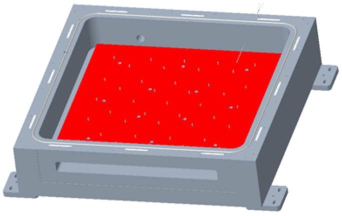

Figure 3. Chamber and Hot plate

3. Design of Lift system

In order to receive the glass panel from outside, a lift system capable of up-down motion within the chamber is required.

3.1. Lift pin

During the process, the glass panel is supplied to the bake module through the transfer module. In the bake module, a lift pin that can move up and down is required to supplwhy the glass panel from the transfer module and place it on the proximity pin. Lift pin is shown in Figure 5.

The coated glass panel is transferred to the lift pin through the transport module. The Lift pin must also take into account deformation. The permissible deformation of the glass panel during the lifting is less than 200 micrometers.

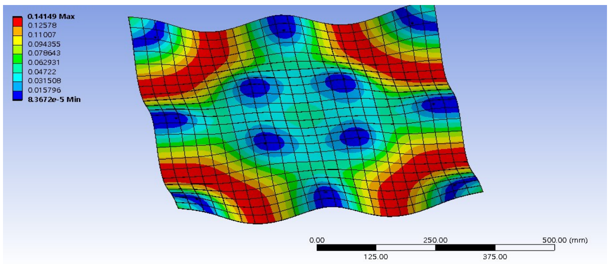

Figure 4. Deformation simulation result of Glass on the lift pins

During the simulation, the maximum deformation of the glass panel due to the lift pin was 0.141 mm, which is within the allowable deformation range. The simulation result is shown in Figure 4.

3.2. Lift actuation system

The lift pin is fixed to one middle plate, and the middle plate can be driven in the Z-axis direction by an external motor. The lift pin is located inside the hot plate during the Bake process. When supplying the glass panel, make sure that it is longer than the proximity pin. A limit sensor is used to specify a limit so that it does not exceed the specified overall driving range. Lift actuation system is shown in Figure 5.

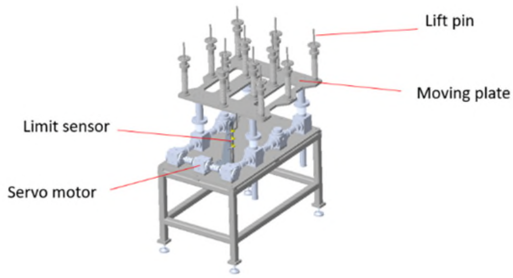

Figure 5. Lift actuation system

4. Manufacturing of chamber system

Based on the design, the hot plate and lift system were actually manufactured, as shown in the figure below. Unlike in the simulation, the deformation may not be uniform due to assembly and manufacturing tolerances. It is expected that the simulation can be verified through baking experiments.

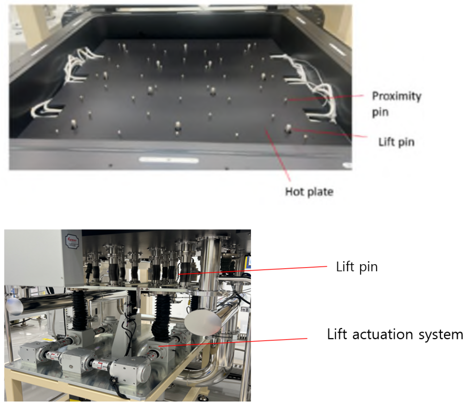

Figure 6. Manufactured chamber system

5. Conclusion

In this research, the core modules of the chamber for the panel bake process were designed. The deformation during the process through the design of the hot plate and proximity pin was confirmed. The deformation during transport through the placement of the lift pin in the lift system was confirmed. The core modules were manufactured to complete the entire chamber. In the future, the temperature distribution test of the hot plate in the chamber will be conducted to confirm the temperature uniformity.

Acknowledgement

This work was supported by the Korea Evaluation Institute of Industrial Technology (20023103, KM250011) funded By the Ministry of Trade, Industry & Energy(MOTIE, Korea)

References

:

[1] Hamid Eslampour et al, “Low Cost Cu Pillar fcPOP Technology”, Electronic Components and Technology Conference, 2012. ECTC 2012. 62nd, San Diego, CA, pp.871-876, May 29th-June 1st, 2012.

[2] C. Melvin, et. al., "Fan-out packaging: a key enabler for optimal performance in mobile devices," Chip Scale Review, Vol 21, No. 1, 40-44, 2017.