Development of Die-bonder with Multi & Matrix Picker and Placer to Increase Production Capacity

PilJune Kim, YongDae Ha, HyunHo Park, JungHee Park

***Abstract*— In Back-End process of semiconductor manufacturing, Die-Bonding is one of the process that bond chips on wafer to PCB(Plastic Circuit Board). Due to the nature of the rapidly changing semiconductor industry, production speed is one of the most important topic. Therefore, A machine equipped with MMPP(Multi-Matrix Picker and Placer) was developed. P&P(Picker and Placer) is a part of machine that pick and place a die, it is the most essential parts in Die-Bonder. In case of existing machine, it has a P&P that grab a die from wafer, then translate to position of PCB and attach the die on it. In this study, the machine with MMPP(Multi and Matrix Picker and Placer) was developed to increase UPEH(Unit Per Equipment Hour). This developed machine has 2 P&P. They grab the die, then move to position of PCB and attach all die on it. And each P&P has 6 collect which directly contact with the die. Therefore it can grab 6 die without bonding. The advantage of this method is that it reduced the time to move between PCB and Wafer and increased UPEH by 2.1 times using Multi-P&P compared to existing method SOPP(Single One Picker and Placer). It was measured by producing 16Gb-MLC(Multi Level Cell)-nand flash in all experiments. This new structure of MMPP was applied to the machine but it was designed to keep the same size with existing one. The authors describe layout of the machine and performance properties and discusses the analysis of productivity growth and accuracy based on experimental results. It was confirmed that UPEH of the machine with MMPP is 2.1 times than S-300 that is existing machine and accuracy is the same in both machine.**

***Index Terms*— Die-bonder, Picker and Placer, Picking, Bonding, UPEH**

I. Introduction

Die bonding is one of the most important processes in IC Packaging. The procedure about pick and place movements is presented in Fig.1. The bond head is used to grab a chip from the tape, then translate to the PCB or lead frame and attach die on it. The process is called the pick and place movement. Appropriate bonding time and force for the attachment is needed to ensure a strong bond.

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The quality and speed of die-bonding significantly affect to IC packaging. After die-bonding, suppose the quality of die-bonding is poor, the following wire-bonding process will be affected and will lead to the defects of the IC packaging. A higher pick and place movement speed ensures a larger production capacity. Hence, the die-bonding process depends on the speed, accuracy and precision of the pick and place movement. How to design a better P&P device is always an important topic of the equipment manufacturing.

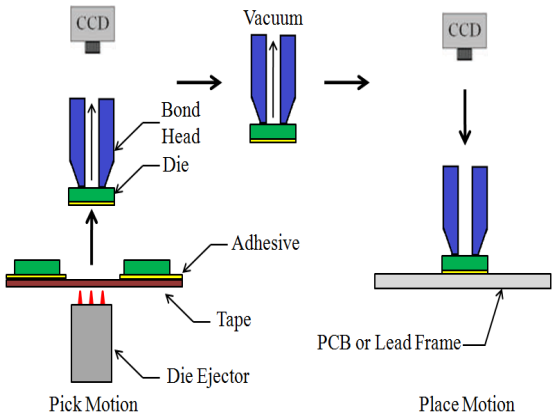

Fig. 1. Simple layout of machine and the name of each part[1]

As the P&P device plays an important role in the die bonding process, there are many scholars and developers devoted to the related research topics during the past decades. Noted literatures include [1-3]. For example, the cam-driven P&P device invented by Lai[2], the crank-rocker mechanism designed by Teo[3] show a considerable degree of creativity and contribution. Although these P&P device was invented for fast and accurate movement of bond head to Z axis, their structure is still SOPP(Single One Picker and Placer). In the future, it will be difficult to increase production using this structure. And recently, S company has developed S-400, H company has developed D-800. But those machines have SOPP. As a result of that, they couldn't increase UPEH by more than 10% compared to the previous one.

In order to lead market in the fierce competition of the industry, it is necessary to design a new structure of P&P that is capable of providing high quality and mass product. For that reason, increasing the production within the same hours among the machine's performances became the most important topic. As these demands of the market, MMPP which is a new structure of P&P was developed to increase UPEH. It has been confirmed that MMPP increased the production based on the comparison of UPEH, accuracy in both developed and existing machine(S-300 made by S

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company). The results were measured in 16Gb MLC(Multi Level Cell)nand-flash. UPEH in die-bonding process depends on characteristic of the product because of the differences for die size, die thickness, bonding time and picking time. In order to eliminate these factor, the results were relatively compared in both machines.

II. Result and Discussion

The developed die-bonder has symmetrical structure with two parts. But is was designed to maintain the same size with existing machines.

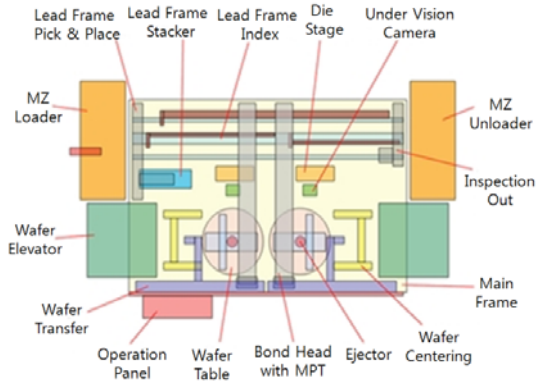

Fig. 2. Simple layout of machine and the name of each part

Wafer table which occupies the larger inner space due to securing 12 inch wafer was transformed from 4 axis(x, y, z, theta) to 2 axis(z, theta). As wafer table doesn't move in the x and y direction, freed more space up. Bond head with P&P replaced the function of wafer table. Meanwhile, ejector plays a role to peel die off from wafer. It moves to the same position on wafer with bond head. Then, it starts to peel die off in accordance with programmed sequence.

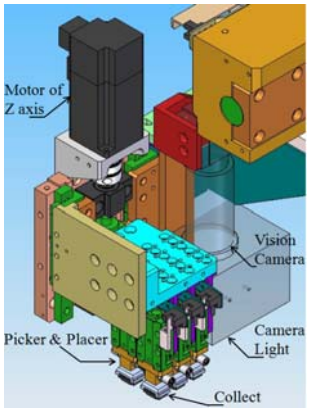

Fig. 3. The Drawing of Bond Head with Matrix Picker and Placer

As shown in Fig.3, bond head consists of several parts. P&P has 6 collect which directly contact with die. Collect usage is different as types of product but use 3~50000 times on average in non-MPP. Because each MPP has 6 collects, it make replacement cycle increase by 180000~300000 times. Basically, machine's concept is multi-type. As shown Fig.4, it has 2 MPP. It also has 2 ejector, wafer table and bond stage..

In order to compare the production between developed and existing machine, production time to bond 240 dies on a PCB was measured at each machine. Table.1 shows the result. Based on those production time, UPEH was calculated. This result shows that machine with MMPP increased the production by 2.1 times. This experiment didn't include the time of wafer loading, unloading and wafer align.

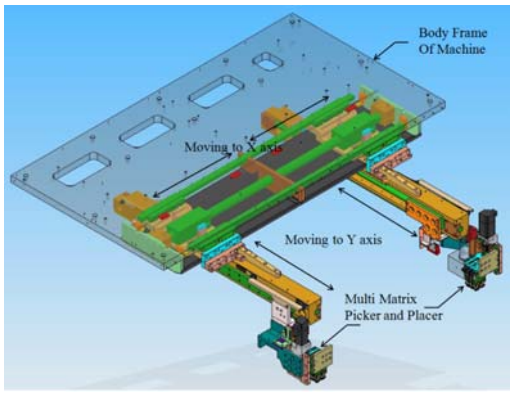

TABLE I
Measured Data of Bonding 240 Chips on PCB

	MMPP	Non-MMPP
Time to bond 240 chips on a PCB(s)	236.5	497
Time to bond a chip (s)	0.985	2.071
UPEH (Unit Per Equipment Hour)	3653	1738

Fig. 4. The Drawing of MMPP(Multi-MPP)

Table.2 shows the cycle time of each sequences. Each data at the table means the time that bond head move in x, y and z direction and vision camera recognize a die. Recognition of vision for second, fourth, sixth collect time are very short compared to others. Because, they recognize the die prior to their sequence. This new method was newly applied at this machine.

TABLE II
Measured Data of Bonding 240 Chips on PCB

Sequence	Time(ms)
Recognition of vision for first collect	790
Picking of first collect	558
Recognition of vision for second collect	31
Picking of second collect	579
Recognition of vision for third collect	398
Picking of third collect	531
Recognition of vision for fourth collect	31
Picking of fourth collect	586
Recognition of vision for fifth collect	432
Picking of fifth collect	539
Recognition of vision for sixth collect	31
Picking of sixth collect	598
Recognition of backside of die	812
Recognition of PCB	735
Bonding	4571
TOTAL	*11222*

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Vision camera was used to measure the accuracy of die on PCB.

Vision camera : Progressive scan CCD Sony ICX274AL, 1600(H) x 1200(V), pixel size 4.40 x 4.40 μm

Measurement method is as shown in Fig.5. First, pattern1 on PCB and pattern2 on die are saved. Based on this standard data, accuracy was inspected. Accuracy is the discrepancy between pattern1 and pattern2. After bonding in the developed and existing machine, die accuracy of measurement results are shown in Fig.6.

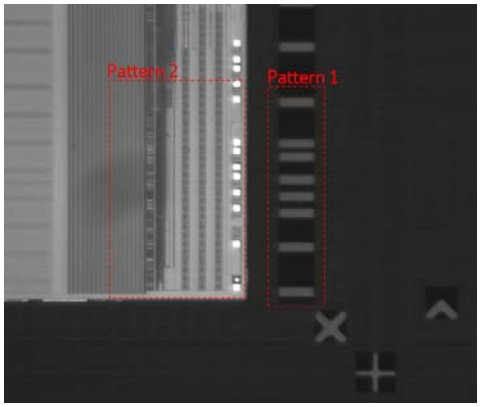

Fig. 5. The recognition image using vision camera(ICX274AL) for inspecting accuracy of chips

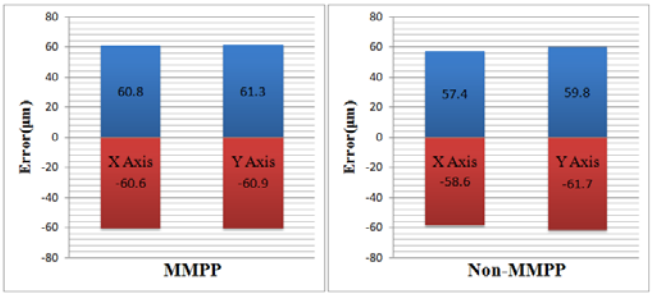

Fig. 6. The result of accuracy after bonding chips

20 PCB in each machine were measured in this experiments. The Y-axis of the graph represents the error of accuracy. Maximum error was 3.4μm between MMPP and non-MMPP. Accuracy in die-bonding process is affected by condition of every parts in machine and usage count of collect. It is very sensitive to the changes. There are also variations even in same machine and same product. Therefore, 3.4μm error can be ignored and accuracy of both machine was the same.

III. Conclusion

In order to improve the productivity of die-bonder, the machine with a new type of mechanism MMPP was developed. Although developed machine is the same size with S-300(which is the name of machine) made by S company, it ensure the same quality with existing machines and increase UPEH more than 2 times. As a result of producing 16Gb-MLC-nand-flash at each machine, it is confirmed that UPEH of the machine with MMPP is 2.1 times than S-300. And there is 3.4μm of the accuracy error between existing one and MMPP but it can be ignored. From the result of this experiments, we concluded that MMPP is very applicable Picker and Placer in die-bonder machine.

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