CHIPPING FREE PROCESS FOR COMBINATION OF NARROW SAW STREET (60UM) AND THICK WAFER (600UM) SAWING PROCESS

MOHD SYAHRIN AMRI
DAVID LIEW
FUAIDA HARUN

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

CHIPPING FREE PROCESS FOR COMBINATION OF NARROW SAW STREET (60UM) AND THICK WAFER (600UM) SAWING PROCESS

by

[1] Mohd Syahrin Amri, Senior Instructor Engineer
[2] David Liew, Development Engineer
[2] Fuaida Harun , Senior Development Manager

[1] Universiti Teknikal Malaysia Melaka
Hang Tuah Jaya, 76100 Durian Tunggal 76100 Melaka Malaysia
Phone: +606-555 2181, Fax: +606-331 6247,
Email: syahrin@utem.edu.my

[2]Infineon Technologies (Advanced Logic) Sdn Bhd
Batu Berendam FTZ, 75350 Melaka Malaysia
Phone: +606-232 8718, Fax: +606-251 8140

ABSTRACT

Chipping free is a dream for wafer sawing process. With current high complexity of wafer technology plus the drive for cost reduction by narrowing the saw street width, it is a challenge which requires huge effort for wafer sawing process to achieve chipping free process. Higher density of metallization causing higher blade loading during mechanical sawing. This leads to chipping penetrating under the guard ring and damaging the active area. This paper will share all the activities towards chipping free process on a device involving optimization through mechanical sawing, infra red camera and laser grooving process. Blade selection involving various diamond grit size, different concentration, slit design and low k types only able to minimize the occurrence but not totally eliminate it. Finally by performing laser grooving, significant results were achieved with zero chipping occurrences. In addition, suitable laser frequency selection is also important to ensure the best performance. In this case higher frequency laser grooving in combination with mechanical sawing process found to be able to meet the requirement.

Keyword – chipping/peeling free, seal ring, laser grooving

1. INTRODUCTION

Wafer sawing is a cutting process which separate dies from a piece of wafer. The sawing process can be done by mechanical or laser process. The area that has been cut away during sawing process is called sawing street. On sawing street, chipping or peeling level is the key factor to determine the quality of the unit. Once the chipping/ peeling entering the guard ring or circuit area, it will ruined the function of the die itself. In wafer sawing process, target always to minimize chipping but sawing without chipping is a dream for all engineers. There are a lot of efforts towards these activities which require a huge effort and from this paper will share the activities done involving methods and parameter optimization.

This paper focus mainly on developing a sawing process with key objective to eliminate chipping or peeling from touching the seal ring. Chipping is define when the sawing street structure or silicon material are totally removed while peeling criteria is a condition when only top layer portion being removed during sawing process. Further illustration could be referred in Figure 1.1

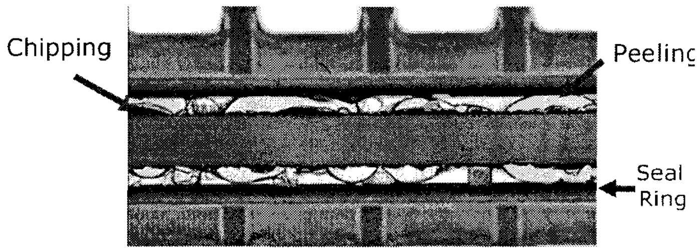

Figure 1.1 (Chipping / Peeling)

The key challenge for chipping/peeling free process when existing of high density of Polyimide and PCM (Process Control Monitoring) structures on the sawing street. Definition of Polyimide and PCM structures can be referred in figure 1.2.

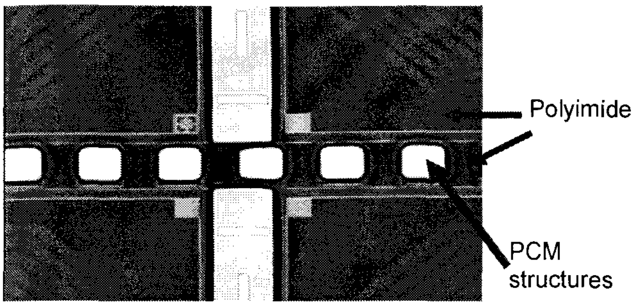

Figure 1.2

The PCM structure contains hard metal such as Aluminium and Copper which may attached to the diamond blade and causing high blade loading during sawing. Higher peeling and chipping can be easily seen on this area compared to the clean area. This could be refer to figure 1.3.

Figure 1.3

Once the blade loading is high it can cause scratch or chipping on the side wall as well. This occurred when the hard metal material stuck in between the diamond and rubbing with the sidewall area. However, so far the semiconductor industry has paid little attention to the fact that the same mechanism causing chipping is also responsible for inducing microcrack [2] This statement can be proven by referring to figure 1.4.

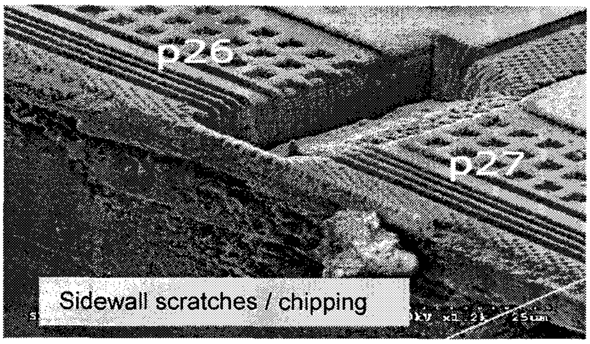

Figure 1.4

The sidewall scratches / chipping can introduced to quality issue whereby it can penetrate under the seal ring and destroy the chip function by going into the active area. Though blade selection is very important in order to ensure the metal structure can be released easily during sawing and not stuck between the diamonds and caused sidewall scratches. The crack penetration can be seen in figure 1.5 below

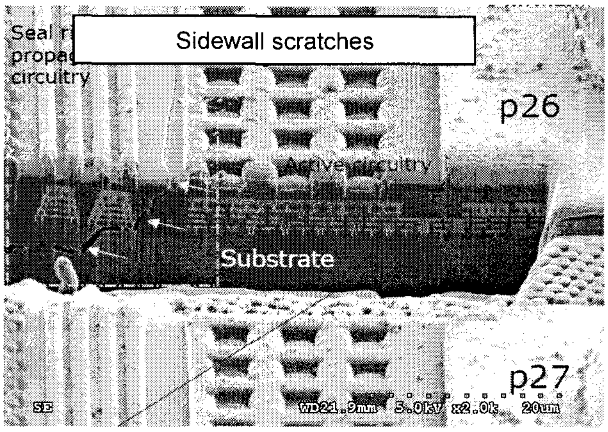

Figure 1.5

In normal cases the peeling or chipping can be blocked by the seal ring and maintain the chip quality, however with the existing of sidewall scratches the quality issue becomes more complicated since the crack from the sidewall scratches move under the seal ring and penetrate to active area.

In order to maximize the area yield of wafer, the street width, i.e the space between elements reserved for separation cut, has to be kept as small as possible [1]
The additional challenges for these activities are wafer having two critical criteria which combining narrow saw street (60um) and thick wafer (600um). This had exceeded the blade manufacturing standards on the blade thickness vs the blade exposure ratio. Improper combination on thin blade with high exposure blade may

cause blade wobbling. Blade wobbling resulting to instability during wafer sawing and will cause non straight line during sawing and finally causing broken blade. Broken blade can cause quality issue such as bad chipping and cracks.

2. EXPERIMENTAL SETUP

Before assessment starts machine had been calibrated and perpendicular check had been performed on chuck table. This is to ensure the machine is in good condition and to minimize variation. All blades during the assessment had been dressed using silicon wafer. Water temperature been fixed at 20°C ± 2°C during the assessment. For investigation purpose, a 600um wafer thickness with 8 inch wafer size had been selected with each samples 40 readings had been collected. Die size is fix to 5.13mm x 5.28mm dimension with 60um saw street width. For laser application, a coating will be applied to the wafer surface to protect the wafer surface from any silicon particles contamination. The coating then will be removed during wafer cleaning process. Inspection will base on few quality sequence criteria. Firstly topside chipping / peeling will be inspected, if the result is good then will continue with sidewall chipping and lastly backside chipping inspection. If one criteria is fail, the next inspection item will not proceed. Inspection base on high power scope ranging from 50x up to 500x magnification. Scanning electron microscopy (SEM) will be used to confirm the sidewall scratches/chipping occurrence.

3. COMPARISON OF DIFFERENT SAWING METHOD

The experiment conducted base on mechanical and laser sawing process. For mechanical sawing Disco DFD6340 sawing machine was used and for laser sawing using DFL7160.

3.1 Mechanical Sawing

In these activities two sawing methods had been tested. The first method used normal front side sawing while second method is using backside sawing approach. Backside sawing used the infra red camera feature. The machine will do alignment from backside area and then sawing will continue from the wafer back instead of front side. This is to see the peeling or chipping performance when polyimide or metal structure is being sawn at last process. Further illustration could be refer to figure 1.6 and 1.7 for further understanding.

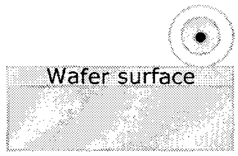

Figure 1.6 (Normal front side sawing process)

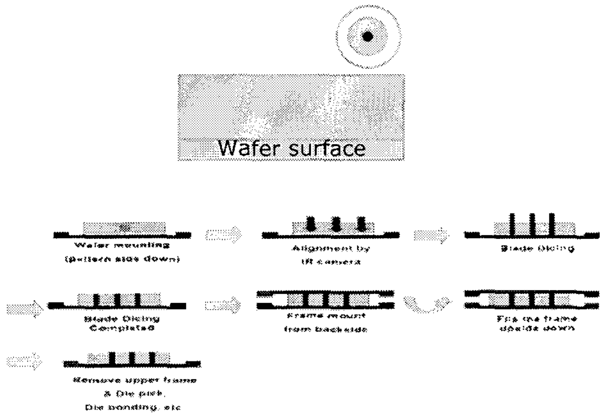

Figure 1.7 (Backside sawing using infra red camera)

In mechanical sawing assessments there were few activities conducted base on
1) sawing parameter optimization on cut depth, feedspeed and RPM
2) blade type assessment which covered low k blade and slit blade
3) varies of diamond blade concentration and grit size
4) UV and Non UV mounting tape assessment
5) Surfactant involvement
6) Varies of cutting methods
7) Grinding towards thinner wafer thickness (standard 250um thickness)

3.2 Laser Sawing

The modern technology of the laser (light amplification by the stimulated emissions of radiation) has penetrated the ancient art of diamond cutting [3] .In this assessment two types of laser frequency had been evaluated. Assessment cover with low frequency laser (10 – 30kHz) and high frequency laser (60 – 150kHz). Laser process only applied on first cut while the second cut remain with mechanical sawing. Both are using Nd YAG laser and with 5 passes of laser grooving or also known as paw cut. The 5 passes of laser cut including mechanical saw being illustrated on figure 1.8 below.

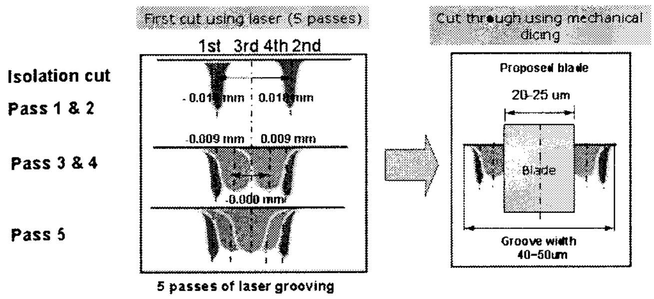

Figure 1.8

4. RESULTS AND DISCUSSION

3.3 Mechanical Sawing

From all assessment showed that mechanical sawing not able to achieve peeling free process. Cutting method base on single cut and step cut do not have significant impact. Parameter optimisation towards blade height, feedspeed and various blade RPM not able to achieve the set target. All assessment on mechanical approach involving different diamond grit size and diamond concentration also do not show any significant improvement towards peeling free results. Nevertheless lower concentration and bigger grit size do reduced number of peeling occurrence on the sawing street. Lower feed speed and cutting height also reduce number of peeling however not able to eliminate it.

3.2 Laser Dicing

Laser dicing does provide positive results towards peeling free process. However laser frequency selection is very important in order to achieve the desired target. Base on assessment made, low frequency laser not able to provide good results and the performance is comparable with the mechanical sawing. High frequency laser does bring significant impact and provide positive results in the assessment. Even with combination with mechanical sawing on the second cut still manage to provide convincing peeling free process. Figure 1.9 and Figure 2.0 are the comparison results between mechanical and high frequency laser sawing.

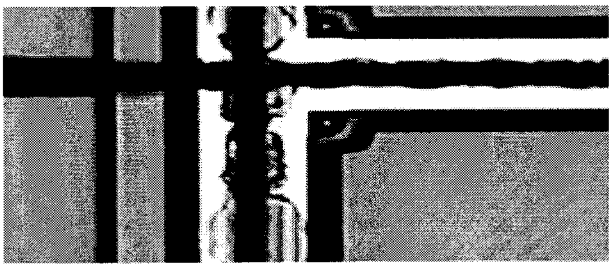

Figure 1.9
(Mechanical sawing only, peeling observed)

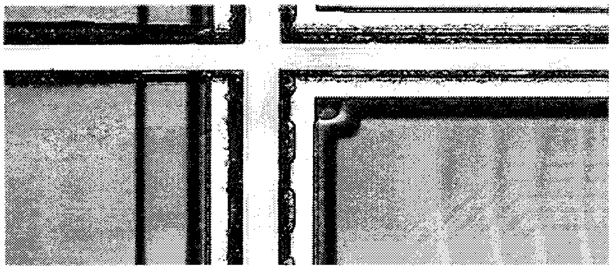

Figure 2.0
(High Frequency laser and mechanical sawing, No peeling observed)

Below are results summary base on activities evaluated to achieve chipping / peeling free process

No	Assessment Method	Peeling free
1	Blade height assessement ranging from 5um to 190um of wafer thickness on first cut	- ve
2	Feedspeed assessment from 1mm/s up to 100mm/s	- ve
3	Cutting method single and stepcut	- ve
4	RPM ranging from 30K up to 55K	- ve
5	Diamond blade using low, medium and high concentration	- ve
6	Diamond grit size with average 3 & 4 um mash size	- ve
7	Low K and Slit Blade assessment	- ve
8	UV and non UV mounting tape	- ve
9	Surfactant added	- ve
10	Reduce wafer thicness from 600um to 250um	- ve
11	Low Frequency Laser	- ve
12	High Frequency Laser	+ ve

. 5. CONCLUSIONS

From the assessment showed that only high frequency laser manage to produce peeling / chipping free results. For 60um saw street and 600um wafer thickness, it is recommended to combine high frequency laser and mechanical sawing as a sawing method. It is important to use step cut during sawing and ensure that the first cut using high frequency laser application. This is to ensure the metallization on sawing street to be removed without any peeling/chipping occurrence. Since laser sawing has limitation to cut thick wafer, it is require using mechanical sawing as the 2nd cut. With this combination, it has proven to be the best sawing quality performance base on 60um kerf and 600um wafer thickness criteria for chipping/peeling free process.

6. ACKNOWLEDGEMENTS

The authors wish to acknowledge Disco, KNS and all Infineon team members (especially David Liew and Fuadia Harun) for their supportive role in making of a successful project.

7. REFERENCES

[1] Gatzen HH: Investigations Regarding The Operating Range Of Ultra Grinding Wheels on Altics, page 1

[2] Gatzen HH: Dicing challenges in microelectronics and micro electro-mechanical systems (MEMS), page 1

[3] David M. Baker: Revolution in Diamond Cutting: Laser Sawing of Diamond Crystals , page 1