

Cutting GaAs Devices Without Blade Dressing

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Abstract

This extended abstract addresses a saw defects, the severe backside chipping, when cutting GaAs devices. The author reveals the mechanism of saw blade early failure mode and provides a solution: chemical refreshing saw blade instead of mechanical dressing. This solution improves sawing quality, fully automatic saw throughput, and reduces consumable cost of saw blades. In general, this concept is applicable to improving the cutting of other fragile semiconductor materials as well.

THE PURPOSE OF THE WORK

Backside chipping is one of major technical challenge when cutting GaAs devices^[1]. The project was designed to address the constraints (severe backside chipping) still commonly experienced even in latest improvements.

When a new blade is installed and dressed, the sawing device experiences an acceptable minimum of backside chipping. After a short period of cutting, the backside chipping becomes increasingly worse. Finally, blade maintenance, either dressing the blade or replacing it with a new one, needs to be done, otherwise, excessive backside chipping will scrap the entire wafer. As a result of this issue, the saw blade has to be dressed in few thousand cuts, and usually blade has to be replaced before its exposure reaches limits. Therefore, the fully automatic equipment cannot run in fully automatic mode at all times. It undermines the efficiency of fully automatic equipment and not to mention of blade cost. This project focused on discovering the early failure mechanism of the sawing blade and came up with a practical solution. Therefore, This paper addresses the dicing quality issue (backside chipping), as well as improving equipment (saw) throughput and reducing blade cost.

THE BLADE EARLY FAILURE MECHANISM

Historically, the metal blade was sharpened by dressing it on a silicon wafer, or replacing it with a new one. The experiment revealed that the blade had not truly lost its cutting capability, because the abrasives (synthetic diamond) had not been significantly lost at the edge of the blade. The blade's early failure was responsible for causing this type of saw defects – backside chipping.

As shown on figures (4 and 5) on page 4, the black material closed to the edge of the blade was a mixture of the saw dust (GaAs) and adhesion from tape material. The mixture still possessed some stickiness and was loaded up at the areas closed to the cutting edge. Sooner or later, the

mixture accumulated high enough to begin spreading to the adjacent area. Since the exposure of blade abrasives was covered by the mixture, the cooling condition at the cutting edge of the blade was deteriorated. At this time, when the abrasives were covered by the mixture, if the blade was dressed on a silicon wafer doing so would re-expose the abrasives partially, but it would not remove the mixture thoroughly. Therefore, the dressing cycle would become shorter and the blade working condition would become increasingly worse. Eventually, the edge of the blade would be damaged and severe dicing defects, back side chipping, would occur.

This kind of blade failure was an “early failure mode”, because the abrasives on the blade were not lost. The abrasives were mostly being covered by mixture of dust of GaAs and adhesive material.

THE SOLUTION: CHEMICAL REFRESHING BLADE WITHOUT DRESSING

The root cause is that the blade's working condition becomes deteriorated, but the blade abrasives are still remained and usable. Therefore, refreshing a blade without dressing became possible. Further more, running saw in fully automatic mode without interrupting by blade maintenance has been studied. The solution came up. Chemical refreshing saw blade maintained working performance of the blade. It improved the saw throughput and reduced consumable blade costs by maximizing the level of full automation cuttings and by extending the life of the blade.

The chemicals used for removing the mixture loaded on the blade must provide efficient removal of GaAs particles and adhesives; must be easy to use; and must maintain the safety for products and the working environment.

There are two chemical solutions widely used in device fabrication that are practicable for this application. They are Acetone and a mixture of H₂O-NH₄OH-H₂O₂ (3:1:1 by volume). A procedure for refreshing the blade is as follows. This blade refreshing procedure can be done in few minutes:

1. After every 500 to 600 street cuts on a 6-inch GaAs wafer, or after accumulated cutting length has reached about 6,800 centimeters, Pause the operation in fully automatic dicing mode. Stop the blade. The work piece (product wafer) should remain on the chuck at pause position until the resumption of fully automatic cutting mode.

2. Rise the blade cooling water nozzle.
3. Spray Acetone at the lower edge of the blade while holding the clean room wiper at the position that is just touching with the edge of the blade. Spin the blade manually for several turns.
4. Spray the 3-1-1 solution to remove the GaAs particles in the same fashion that the Acetone was sprayed.
5. Lower the blade cooling water nozzle.
6. Turn on the blade cooling water and blade spindle to rinse the blade and the adjacent area.
7. Push the start key to resume the fully automatic dicing mode.

Removing GaAs dust actually is an etch process of the GaAs by alkaline H_2O_2 solution. The dissolution rate kinetics is controlled mainly by the H_2O_2 concentration. GaAs dissolves in the alkaline H_2O_2 solution via a chemical rather than an electrochemical mechanism [2]. The fresh mixed 3-1-1 solution could last more than two days, but it needs to be kept in safe place.

FIGURES

Figure 1: After die pick-place, shown the die with severe backside chipping (50x)

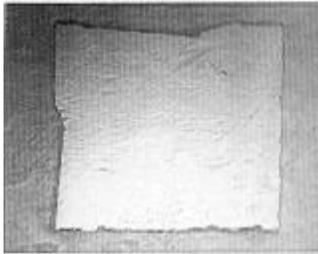


Figure 2: The cross section view of a die with backside chipping. Noticeable perfect front side dicing quality and worse back side chipping that extended more than third of the die thickness (100x)

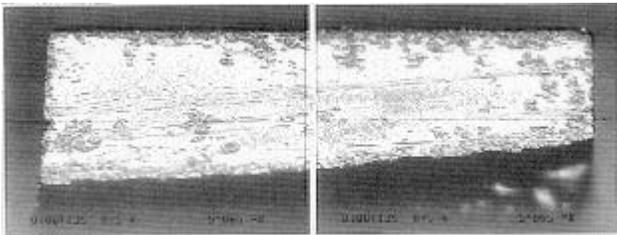


Figure 3: The blade with total street cuts of 500. Shown some black stuff at the edge of a saw blade. That black stuff is a mixture of GaAs saw dust with adhesion material from dicing saw tape. The black mixture will grow out as blade cuts increasing. (500x).

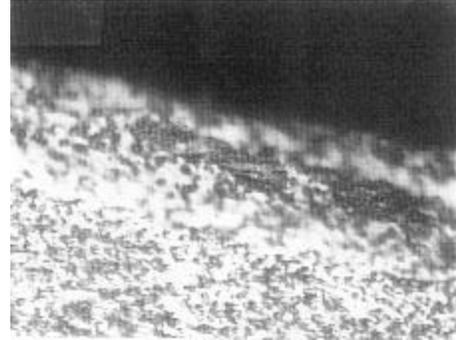


Figure 4: The blade with total cuts of 1,000 without blade dressing. Shown the edge of the blade. Noticed accumulated black mixture getting larger. (500x)

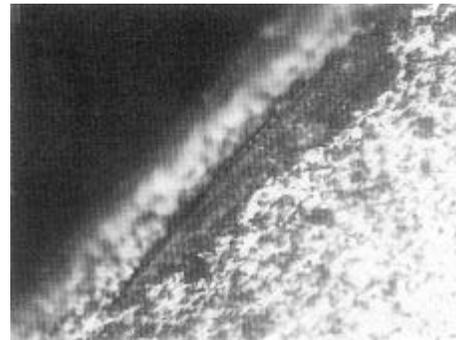


Figure 5: Shown the blade with total street cuts of 3,000 after refreshing by Acetone / $H_2O-NH_4OH-H_2O_2$

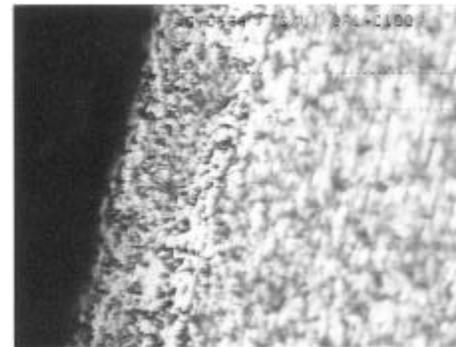


Figure 6: Shown the edge of the blade with total street cuts of 6,000. The blade was refreshed for every about 600 cuts. (500x)

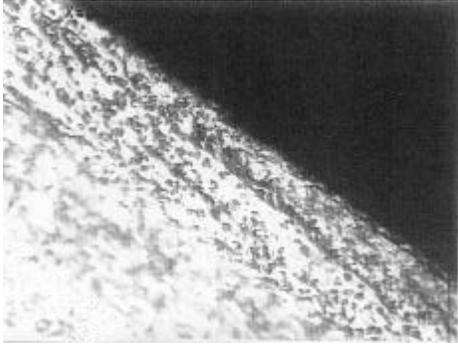


Figure 7: Shown the edge of the blade with total street cuts of 10,000. The blade was refreshed for every about 600 cuts. (500x)
The blade is still usable.

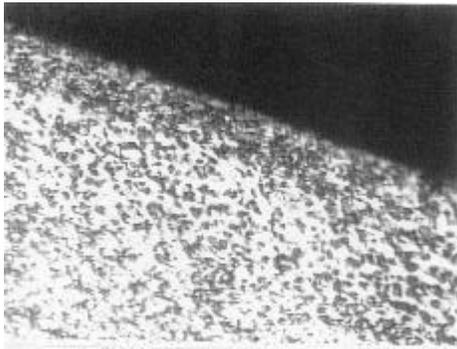
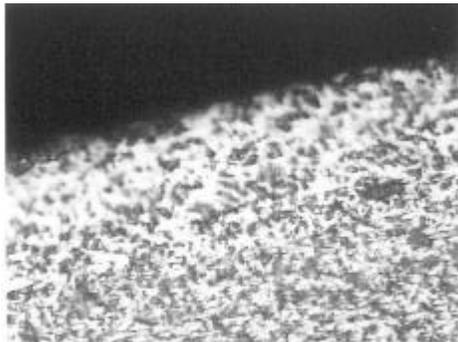


Figure 8: Shown the edge of a new blade with initial dressing. (500x)



CONCLUSIONS

1. The existence of severe backside chipping after a blade has reached a few thousand cuts is a common constraint for efficiently using fully automatic saws.

Blade early failure is responsible for this type of backside chipping.

2. Chemical refreshing of the blade is a practicable solution. Acetone removes adhesives, and solution of $H_2O-NH_4OH-H_2O_2$ (3-1-1) removes GaAs dust. After refreshing the blade, the abrasives are exposed again.
3. By maintaining the fully automatic dicing mode, It implies that there is no need to remove wafer from chuck and to do blade dressing. It implies adding 5% to 10% saw throughput. Meantime, the dicing quality is secured.
4. Extended the life of saw blade 3X, or at least 10K cumulate cuts on 6" GaAs wafers.
5. The concept of blade early failure mechanism and refreshing blade without dressing could easily be applied to the cutting of other fragile semiconductor materials.

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BIBLIOGRAPHY

- [1] Sim Chay Whatt, "Theoretical Basis for Back Surface Chipping of Die at Wafer Saw", Texas Instruments Singapore Pte Ltd. Microelectronic Manufacturing and Testing, pp142, Nov. 1995.
- [2] J.J.Kelly and A.C.Reynders, "A Study of GaAs Etching in Alkaline H_2O_2 Solutions", Applied Surface Science 29 (1987), pp149 - 164, North-Holland, Amsterdam.

