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Selecting Tape for Thin Wafer Grinding

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Introduction

Semiconductor manufacturers face difficult challenges when thinning wafers less than 125um. Some of these issues include damage to the wafer during grinding, difficulty with wafer handling, transport, bowing and warpage. Examining which tapes to use, is only one part of the necessary total tool set changes required to reach thin wafer target thickness goals. However, some of the main issues encountered in thinning can be minimized with the selection of an appropriate protective tape.

Problem Statement

Protective wafer tapes are used during backside wafer thinning; their primary purpose is to prevent contamination during grind from touching the front side device circuitry. The tape is placed on the front side, or circuit side of the wafer preventing particles, water, and grind slurry contaminants from coming in contact with wafer circuitry. Secondary functions of protective wafer tape include cushioning during grinding, which prevents particles that may have been trapped during the taping process from causing stress points on the wafer. During grind these trapped particles, if not absorbed by tape, may later lead to wafer breakage. Tape also can provide support to the wafer to allow for easier handling during and after grind.

Tape selection becomes important because the topography of wafer circuitry can differ from device to device. For instances, some wafers have bumps on them which must be balanced by tape glue. Bump height, distance between bumps, and location of bumps can all effect grind outcomes. Absorbing the bumped areas with tape will

fill in the air pockets between the bumps and create a more even grinding platform.

Protective wafer tape should adhere strong enough to seal the edge of the wafer and not lift during grind, thereby preventing contamination from occurring. However, too high adhesion can sometimes lead to a transfer of glue residue onto the sensitive front side of the device. Wafer front side topography may have various metal circuitry as well as photo resist or polyimide coatings. This last point is important because different tape glue formulations will adhere differently to each metal and coating type.

When grinding thin wafers, it is especially important to select a tape which will detape easily from the ground wafer. A minimal amount of force should be required to remove the tape. If high force is required to peel the tape from the wafer, the wafer could break during detaping.

Front side wafer tapes must exhibit higher cleanliness factors than standard backside protective wafer tapes used during wafer dicing. Any glue residue or particle contaminants, including and not limited to PDMS, can lead to issues relating to the reliability of thin die. After grinding wafers, we can look at the storage stability of tapes over time. Due to schedule fluctuations in production environments, tape is often left on wafers before and after grind for more than 1 to 5 days. Since tape adhesive levels tend to increase over time, it is important to select a tape whose adhesive tack strength remains stable over time. In addition, by examining particle counts on a wafer detaped 1 day after taping vs. 5 days, we can gauge which tapes leave less particles or glue reside on the front side of the wafer.

Previous Options

Traditionally, tapes with thicker glue layers or base films were thought to provide wafer handling and support, these materials are expensive solutions to the problem and may create additional challenges.

Thicker tapes have been manufactured with thicker base films as well as thicker glue layers or a combination of both. Thicker tapes make it difficult to control tapes Total Thickness Variation. The higher TTV can attribute to higher TTV's on wafers after grinding.

Thicker glue layers can lead to transfer of glue to the front side of wafer devices, as well as increase the adhesive strength of tapes. It is best to choose a tape with the least amount of adhesive strength when grinding thin wafers. Too high adhesive strength can lead to difficulty detaping the thin wafer.

Solution

GT-UV-224 is a new tape designed for thin wafer grinding. The tape was evaluated against 4 other tapes, both UV and Non UV types.

GT-UV-224 performed the best overall across a wide range of performance metrics, which included post detape particle count, TTV of wafer after grind, acid resistance, and ease of detaping. With GT-UV-224, wafers were successfully ground and detaped as thin as 75um.

Benefit 1

Ease of detaping

The primary benefit of GT-UV-224 is ease of detaping thin wafers.

Because GT-UV-224 is a UV wafer tape with low pre-UV adhesive tack ($2.9N/20mm^2$), detaping required almost no pressure point contact on the thin ground wafer. After UV cure, the tape's adhesive strength reduced to near zero, ($.2N/20mm^2$); this minimizes wafer breakage and cracking during detaping. Non UV tapes, required stronger pull to remove the tape from the wafer and the wafers cracked in some instances. A secondary detriment of pulling non UV tapes off thin wafers is that additional force is required to hold down the wafer during detaping. This application of pressure forces tape glue onto the wafer and led to increased particle counts on the wafer surface.

Benefit 2

Low TTV

The thin glue layer, 10um, demonstrated an improved TTV performance on ground wafers. TTV was measured by taking 5 contact points measurements on the wafer using a drop gauge. The thicker tape proved to have the highest TTV variance, as much as 4um, whereas GT-UV-224 was as low as 1um differences.

Benefit 3

Reduced wafer bowing and warpage

The expandable nature of the base film of the tapes prevents pulling on the wafer which may cause bowing or warpage. The tape is a flexible Polyolefin base film and has a Young's Modulus fracture strength (MD) over 58.8 N/20mm and fracture elongation % over 350.

Calculation

Young's modulus E (MPa): =(F/A)/(dL/Lo),
F=stress (N), A=Cross-sectional area (mm2),
dL=elongation (0.5mm), Lo= Initial distance between chucks (50mm)

Experimental

- Method: JIS K7113 standard method
- Sample: 20mm width tapes before UV irradiation
- Tensile speed : 5mm/min
- Initial distance between chucks: 50mm

Benefit 4

Low Particle Count after detaping

GT-UV-224's particle count, measured at threshold of .290um, remained in an acceptable range. Bare prime grade silicon wafers were taped in Class 1000 grind room and then detaped in a Class 100 clean room. Particle counts were measured using a KLA Tencor particle Counter.

Wafers were taped, ground and then detaped at 1 day and then at 5 days. Particle Counting was performed after detaping.

The Control tape exhibited a particle count of 406 after 5 days. GT-UV-224 had a particle count of 393. The tape exemplified good storage stability over time.

Ion Mass Spectrometry PDMS testing was also performed on GT-UV-224 and showed no detectible limits of PDMS, polydimethyl siloxane.

The adhesive was scraped from the base film in the area to be sampled. The scraped surface was extracted with a drop of freshly distilled methylene chloride and in a different location with a drop of freshly distilled Freon. The extracts were transferred to an infrared transmitting substrate and analyzed by Fourier Transform Infrared (FTIR) Spectroscopy using the FTIR microscope. Nothing was detected in the methylene chloride blank or in a Freon Blank. No polydimethyl siloxane was detected.[1]

Benefit 5
Fast UV Cure time

In production environments, GT-UV-224 will improve production throughput because of its faster cure time. The required UV dosage is 150mj at a wavelength of 352nm.

Using a UVO irradiator manufactured by Jlight, lamp intensity was measured using a radiometer. The lamp intensity was 8mw and the wavelength 352nm. The required time to cure GT-UV-224 is 60 seconds. This fast cure time, compares to 3minutes for competitor products using the same tool settings. Production time when processing in high volume environments will be faster using GT-UV-224.

Summary

Although a thick tape can prove to be supportive when handling thin wafers, the tapes pre and post UV tack values are more important. When grinding wafers 10 mil and under, switching from 200+um thick wafer tapes to GT-UV-224 proves to be beneficial. Additional analysis shows detaping can be done on 50um wafers with GT-UV-224.

In addition the soft glue composition absorbed particles trapped behind the tape during taping and prevented wafer scratching before and during grinding. It was easier to detape and the faster cure time, from 3 minutes for the control tape to 1 minute for GTUV224, is helpful in production environments.

Particle counts of GT-UV-224 fell within the acceptable range for front side wafer protective tapes and remained stable over longer time periods.

REFERENCES

[1] Maurius W. Kendall, Xiahua Cai, “Organic Laboratory Analysis Report”, Charles Evans Analytical Group, November 2004.