Improvements in Thin Wafer Handling - Equipment and Material Impacts

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Abstract

The advancements in thin wafer handling for thermal slide debonding processes are multifaceted. Improvements in both the equipment capabilities and the materials for thermal slide debonding are the key topics of this paper. The main points presented include a) the effect of the material on stress experienced by the thinned wafer during debonding and after debonding before tape mount, b) the capability of the slide debonder to debond different size configurations, and c) the ability to remove the thinned device from the thermal slide debonder and proceed to tape mount without the thinned wafer ever being unsupported. These improvements allow for thinner and more fragile devices to be debonded with less stress and more support through the entire process.

INTRODUCTION

Semiconductor companies have been performing wafer thinning as a means of heat dissipation for over 20 years. Fragile substrates are becoming a larger part of the product mix for making chips. As this trend continues, the ability to support these more fragile thinned substrates having high topography throughout the entire backside process from initial thinning all the way through tape mounting and cleaning becomes more important. To make this capability possible, new materials and equipment must be designed to reduce stress on the device throughout the process. Even though more support is needed, it cannot be obtained at the cost of throughput.

The new materials will be benchmarked against industry standards. The new tool designs will be implemented to show a total solution for better processing.

BACKGROUND

Brewer Science and TriQuint Semiconductor have been working together to implement a technology breakthrough that allows for a more stable low-cost-of-ownership process.

Last year TriQuint presented the improved uniformity in final silicon device thickness by using WaferBOND® HT-10.10 material in a single-coat process to achieve a 100-µm coating over 80-µm topography. Since then, Brewer Science and TriQuint have worked together to identify opportunities for further improvements to and optimization on various substrates. Brewer Science has worked on a new material solution to reduce the bowing and decrease the stress during the slide debonding process for silicon substrates, while TriQuint has implemented Brewer Science's temporary bonding materials in several of their processes. Brewer Science has also developed a thin-wafer-handling tool (TWHT) that allows for more support after the thinned device is debonded.

EXPERIMENTAL

Materials: WaferBOND® HT-10.10 material, improved Brewer Science temporary bonding material, and wax.

Tools: Cee® 1300CSX slide debonder, 4-inch TWHT, 6-inch TWHT, SVG 8800 coater/ developer, ATI MWMS-677 tool, C&D film frame cleaner, Ultron UH115 film frame mounter

RESULTS

In continuation of its work with WaferBOND® HT-10.10 material, TriQuint has inserted Brewer Science's bonding materials into its devices that use various materials for substrates.

An example of the potential for improvement is shown in Figures 1 and 2. In Figure 1, the average post-grinding wafer thickness is shown when wax (pink) and WaferBOND® HT-10.10 material (blue) were used as bonding materials. The wafer thickness is comparable between the two bonding materials.

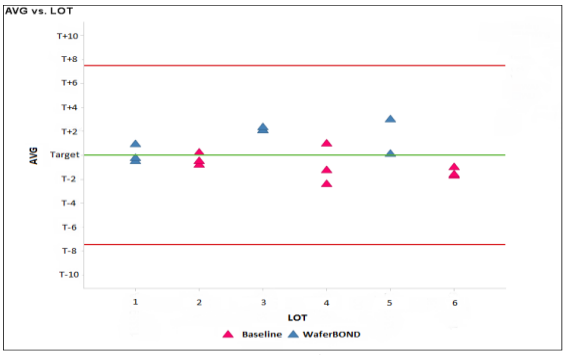

Figure 1: Average post-grinding wafer thickness, wax vs. WaferBOND® HT-10.10 material

In Figure 2, the graph showing the average range or uniformity of structures across the device wafer, it can be seen that the WaferBOND® HT-10.10 material (blue) lots achieved a narrower distribution compared to the lots that use wax (pink) as a bonding material.

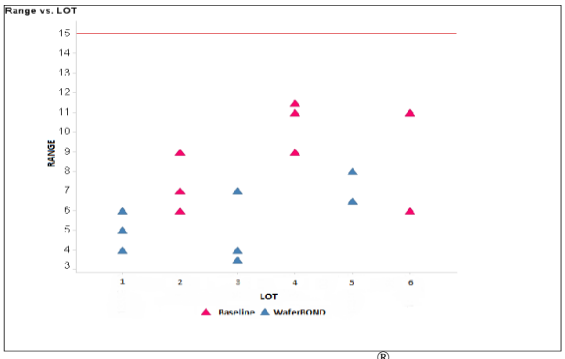

Figure 2: Uniformity, wax vs. WaferBOND® HT-10.10 material

In an effort to further improve the process on some substrates, Brewer Science worked with TriQuint to develop a new bonding material to reduce the stress that the device wafer experiences during the debonding process. The graphs in Figures 3 and 4 show that the improved Brewer Science bonding materials require a lower initial force during the start of the slide debonding process while having a higher velocity compared to WaferBOND® HT-10.10 material.

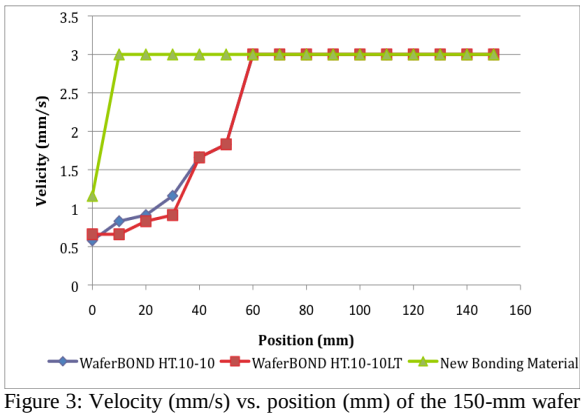

Figure 3: Velocity (mm/s) vs. position (mm) of the 150-mm wafer during the debonding process

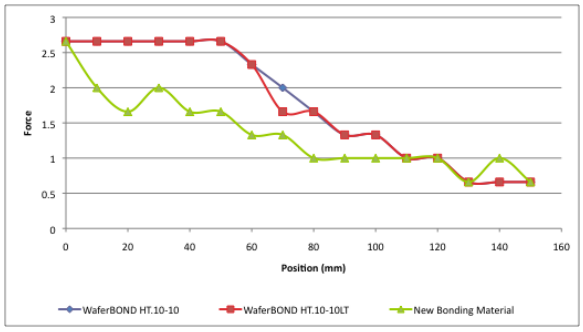

Figure 4: Force (lb) vs. position (mm) of the 150-mm wafer during the debonding process

This performance creates less stress while maintaining throughput during the debonding process. If stress on the wafer is not an issue but temperature is, this material can be debonded at a lower temperature without increasing stress above what is typically seen with the WaferBOND® HT-10.10 material. Even though the improved material allows for lower-temperature processing during the debonding process, it is still as thermally stable as WaferBOND® HT-10.10 material with a decomposition temperature (T_d) in the 250°C range in air.

In conjunction with the new bonding material, Brewer Science also developed a thin-wafer-handling tool (TWHT) for better support of the thinned wafer after debonding until it is tape-mounted to a film frame. Figure 5 shows a debonded thinned wafer in the TWHT. In the process, the wafer goes from demount to tape.

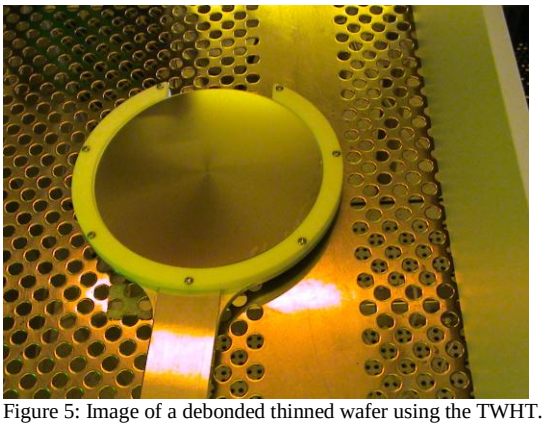

Figure 5: Image of a debonded thinned wafer using the TWHT.

In Figure 6, the thinned wafer is removed from the handle of the TWHT on a puck that fully supports the thinned wafer while it is being transferred to the tape laminator.

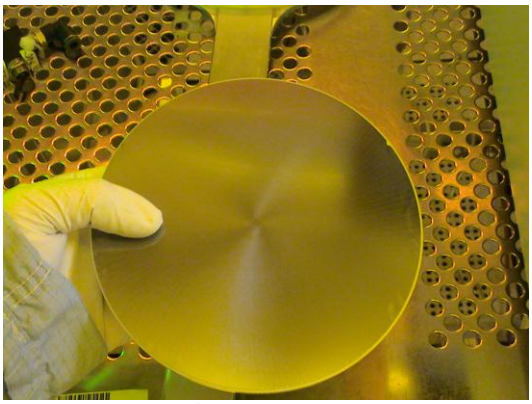

Figure 6: Thinned wafer on the TWHT puck.

The lamination chuck on which the thinned device is placed to be mounted to a film frame was modified to be able to receive the puck from the TWHT, as seen in Figure 7. This allows for the thinned wafer to be fully supported from the time it is debonded until it is on tape. The TWHT can be used for multiple device sizes.

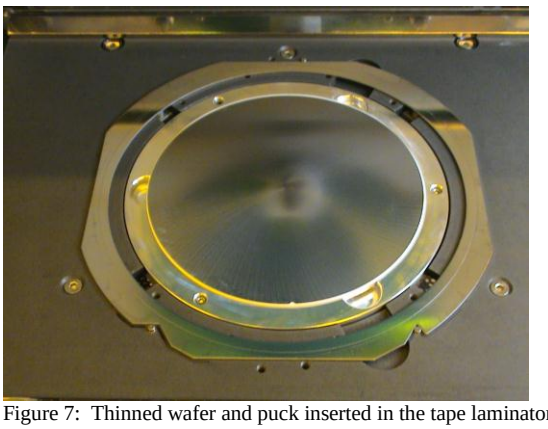

Figure 7: Thinned wafer and puck inserted in the tape laminator

CONCLUSION

Finally, the overall process and uniformity improvement with the Brewer Science bonding materials is seen on all samples. Whether it is through the more uniform thickness achieved with WaferBOND® HT-10.10 material than with the current process, which allows better structure resolution, or through the reduction in stress achieved with the improved Brewer Science bonding material, which decreases wafer breakage, an increase in the yield was achieved.

In addition, the platen design and software employed by the Cee® 1300CSX debonder allows various sizes of device wafers and carriers to be thermally debonded, therefore allowing better support of the device though the backside processes, while the TWHT allows for better support of the thinned device wafer after debonding as it is transferred to tape.

These materials and tools in combination allow for a more stable, fully supported process from start to finish, and the resulting improvements are significant.

ACKNOWLEDGEMENTS

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ACRONYMS

TWHT: Thin Wafer Handling Tool
TTV: Total Thickness Variation