Improvements in Processing - Carrier and Material Impacts

Molly Hladik[1], Aric Shorey[2]
[1]Brewer Science, Inc., 2401 Brewer Drive, Rolla, MO 65401
mhladik@brewerscience.com, (573) 364-0300
[2]Corning, Inc., SP-YE-A10D, Corning, NY 14831
ShoreyAB@corning.com

Abstract:

The advancements in carrier technology for thin wafer handling are multifaceted. The ability to adjust the coefficient of thermal expansion (CTE) of glass to match that of different device substrates is a driving force that can allow implementation of glass carriers in this process technology space. The main points presented include a) a comparison of CTE-matched glass across the different III-V semiconductor substrates, b) the ability of the glass to survive different backside processes without pretreatment that normal carriers, such as silicon, cannot, and c) the ability to negotiate the array of debonding methods. These improvements allow for process developments starting with small substrates that translate to larger substrates that may require different debonding mechanisms. Such improvements provide flexibility in the post-thinning processes that are not available with traditional carriers.

INTRODUCTION

Compound semiconductor companies have been performing wafer thinning as a means of heat dissipation for over 20 years. GaAs wafer sizes started as wafer pieces and now are 150 mm in size and are run at relatively high volume in the world's leading fabs. As volume increases, the size of the substrate will also need to increase further to reduce cost. Moreover, III-V semiconductor substrates are becoming a larger part of the product mix for making chips. As this trend continues, the ability to support these more fragile substrates or thinned substrates with high topography throughout the entire backside process, from initial thinning all the way through debonding, has become more important. To make this capability possible, new materials must be designed which enable the device to be subjected to less stress throughout the process. Even though more support is needed, it cannot be obtained at the cost of materials or throughput.

The new glass carriers will be benchmarked against industry standards.

BACKGROUND

Brewer Science and Corning have been working together to implement a carrier technology that allows for a more stable low-cost-of-ownership carrier that can span all of the different debonding technologies with increased performance.

Glass provides many advantages for use as a carrier in wafer processing applications. First, its transparency provides an opportunity to visually inspect the bond prior to expensive processing operations. This simple, low-cost inspection can have important process and yield implications. A second advantage provided by the transparency is the ability to utilize laser debonding approaches in addition to other approaches such as mechanical and thermal processes. Also, glass has good chemical durability in important chemical environments and provides opportunities for many reuse cycles and lower cost. Finally, and perhaps most importantly, is the ability to adjust the coefficient of thermal expansion (CTE) of glass by adjusting the glass composition. This ability provides the opportunity to manage the warpage, and the associated stress, of the bonded stack. Last year, Brewer Science introduced BrewerBOND™ 220 material. This material allows for a single thick coating application, higher temperature stability, and comparable stress to wax.

EXPERIMENTAL

Materials:
Corning CTE-Matched Glass
BrewerBOND™ 220 Material
WaferBOND® HT-10.10 Material

Equipment:
Cee® 1300CSX Debonder
Dektak Profilometer
Sonix Confocal Scanning Acoustic Microscope (CSAM)

RESULTS

As technology progresses, the ability to move to a lower cost of ownership becomes not just desirable, but a necessity. Moving to CTE-matched glass versus traditional carriers does just that. The glass carriers are less expensive as well as reusable, they survive backside processing that opens up debonding processing options, and they can eliminate processing steps such as performing a CSAM analysis to check the bond line. These capabilities result in a throughput increase.

Substrate	CTE (ppm/˚C)	CTE of Matched Glass (ppm/˚C)
Si	2.6	[Data to be provided in final paper]
GaAs	6.68	
Sapphire	5.3	
SiC	4.0	
InP	4.75	

TABLE 1: COEFFICIENT OF THERMAL EXPANSION (CTE) FOR THE DIFFERENT DEVICE SUBSTRATES AND THE CORRESPONDING MATCHED GLASS.

One of the known benefits that typical wax bonding materials have is little to no material stress before, during, or after processing. This quality is important for processing so that the bonded stack can move through typical backside processing without experiencing handling issues. The bow measurements in Table 2 compare BrewerBOND™ 220 material to WaferBOND® HT-10.10 material across 200-mm wafers. As the size of the wafer increases and the thickness of the wafer decreases, the stress of the materials have more impact. In addition, as the WaferBOND® and BrewerBOND™ materials are thermoplastic in nature, higher backside processing temperatures can now be applied while maintaining support of the thinned device wafer.

Film Thickness (µm)	BrewerBOND™ 220 Material (µm)	WaferBOND® HT-10.10 Material (µm)
25	-1.67	12.84
50	5.26	32.81
100	0.16	44.16

TABLE 2: BOW COMPARISON OF BREWERBOND™ 220 MATERIAL TO WAFERBOND® HT-10.10 MATERIAL ON 200-mm WAFERS.

As the material stress is reduced, the debonding stress during thermal slide is also reduced. Wax materials are usually debonded by thermal means and have very low stress during the process. The BrewerBOND™ 220 material has the ability to debond at a range of temperatures from as low as 150°C to over 200°C.

CONCLUSIONS

As discussed in the results, the CTE match of the glass to the different device substrates allows for uniform expansion of both the carrier and the device during the different backside processes. Also by using CTE-matched glass, any debonding method can be used, whether it is laser, chemical release, thermal slide, or mechanical.

The BrewerBOND™ 220 bonding material allows for lower stress, comparable to wax, during all backside processing and allows for a wider backside process window over wax.

ACKNOWLEDGEMENTS
TBD.

ACRONYMS

CSAM CONFOCAL SCANNING ACOUSTIC MICROSCOPE
CTE COEFFICIENT OF THERMAL EXPANSION

REFERENCES

TBD.