Promex

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DIE ATTACH FILM APPLICATIONS

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Die attach film (DAF) and dicing die attach film (DDAF) have been commercially available since 2000. Epoxy paste adhesives have historically been the sole epoxy material available for die attach, an integral part of component assembly, in particular for wire-bonded devices, but not quite applicable for flip chip assembly. DAF and DDAF are epoxy adhesives which are film based instead of paste based and are attached to the back of the wafer prior to dicing. DAF is sold by the supplier without a support dicing tape, whereas DDAF is sold by the supplier on a stretchable support dicing tape which is partially sawn and subsequently poked by ejector needles during automated die pick. DDAF has gained popularity due to the many advantages of film over paste, driven especially by the growth of stacked die architecture. Because there is no re-shaping of adhesive material from a drop-shape to a thin two-dimensional layer, the process window for film is much wider than for paste material. Engineering intensive processes to control fillet shape, overflow, under-coverage and voiding are eliminated by the use of films. For very thin dies as well as for stacked dies, it is imperative to use film.

There are a handful of suppliers of wafer level DAF. Major suppliers provide the circular DAF sheets in rolls for automatic machine lamination such as shown in Figure 1. DAF can also be sourced as sheets for non-automated lamination. DDAF and DAF material have a shelf life of 6 to 12 months when stored at 0-10°C. They can also be stored at room temperature, but the expiration date is shortened by about half. Hence, the material is only made to order and major suppliers impose a minimum order of up to 300 sheets or 3 rolls. A nonconductive 8" DDAF is around $8/wafer but the conductive version is an order of magnitude higher in cost. One major manufacturer that has a silver filled DAF product will only sell to high volume users offshore. This limit on suppliers can make DAF less cost effective unless they use a subcontractor who has a well-stocked inventory. The cost per wafer of silver filled DAF may be higher, but with the savings in process steps and yield improvement, the cost is very comparable to paste.

Currently both conductive and non-conductive DDAF films are commercially available at various thicknesses. Most suppliers provide 20 to 25um as a standard thickness option. Lower 10um thickness DAF is available but maybe a challenge to procure for low volume users. Electrically and thermally conductive silver filled films are also available at 20-25um thickness and have been deployed at Promex for many QFN device assemblies. QFNs with silver DDAF have passed JEDEC MSL3 for 8x8mm QFN from Promex. However, many high-end applications require higher thermal conductivity and have resorted to DAF with diamond fillers instead.

Promex has been assembling multi-die stacks with diamond filled DAF successfully. Figure 2 shows a cross-section of a 7-die stack die device using a diamond filled film. The silicon wafers have been thinned to 200um before laminating onto the diamond filled DAF. The die on the device wafers with DAF were singulated using a dual spindle dicing saw as shown in Figure 3. Saws with single spindle are not recommended as adhesive stringers and conjoining of die may result. After singulation, die attach using a Datacon 2200 with a heated stage was performed. Each die is pressed down on a heated substrate at a force recommended by the supplier which keeps the die firmly anchored in place. An example of a wafer with silver epoxy DAF during Datacon pick is shown in Figure 4. All DAF'ed die must be subsequently cured at higher temperatures around 150-165°C for

1 hour. One of the biggest advantage of film over paste is the absence of outgassing or void formation during oven cure. The effect on die tilt and die shifting caused by void formation has been a challenge for paste users, particularly for large dies. The bondlines of stacked die of various DAF brands after cure are found to be consistently uniform.

High yield can be attained by good quality control of DDAF material and wafer backside cleanliness. Contaminants either from mishandled DAF or a mishandled wafer can result in problems with missing adhesive film as shown in Figure 5. Poor adhesion may be traced to contaminants such as polydimethylsiloxane (PDMS) [1] which can be removed by Argon gas plasma cleaning. A pass/fail criteria set at greater than 95% DAF visible on die backside is acceptable for good die shear strength.

Wafers with DAF that are diced with improper dicing parameters may exhibit adhesive stringers in the saw streets as shown Fig 6. This is rejectable as the stringers may cover bond pad openings affecting wirebond integrity. Saw dicing parameters must be optimized to eliminate such stringers. Another reject is conjoined die found during pick which is caused by inadequate adhesive singulation due to improper blade depth or worn out blades. Lasers can be used for the singulation of DAF wafers however, this is only cost effective for high volume manufacturing.

ADVANTAGE COMPARISION		DIE ATTACH FILM	DIE ATTACH PASTE
Paste Dispense machine set-up Requirment of dies/wafers		None (less set-up dies)	Engineering intensive & more set-up dies/wafers
Batch oven curing 1hr at 150C - 165C UPH improvement		Partial cure OK with full cure during wirebond	Must Cure 100% prior to wirebond
Die to pad size ratio		1.0	Less than 0.9
Die strength during pick		Reinforced by DAF	No reinforcement
Wafer warpage during handling		Reinforced by DAF	No reinforcement
Bondline		Consistent	Must monitor
Die pick Issues	Con-joined dies	Must control during saw	None
	Missing adhesive	Must control during prep	None
	Stringers	Must control during saw	None
Die tilt and fillet issues		None	Must monitor
Pot life before cure		Hours/day	Minutes<4hrs
DA Cure Issues	Voiding	None	Must control
	Bleed out	None	Must control
	Shrinkage at corners	None	Must dispense proper amount

Table 1

Fig 1. Photo provided by Lintec.

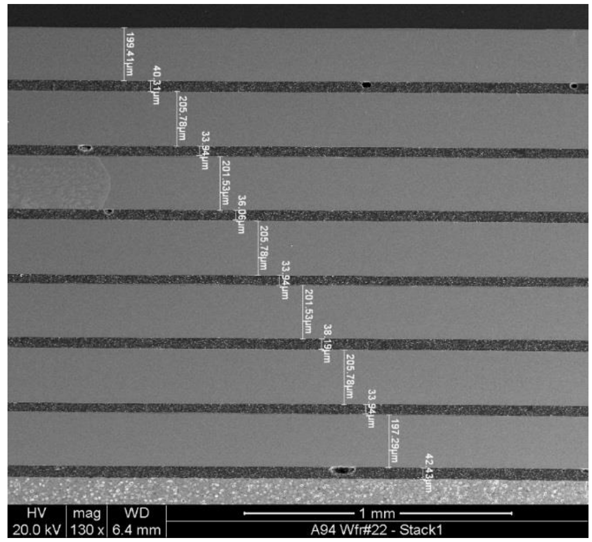

Fig 2. 7 die stack with high thermal conductive DAF.

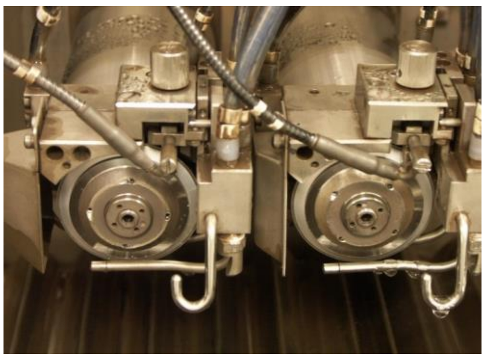

Fig 3 DDAF dicing on dual spindle saw

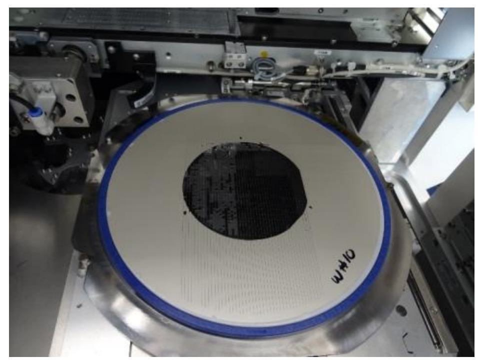

Fig 4 Singulated die on Silver filled DDAF being picked by the Datacon

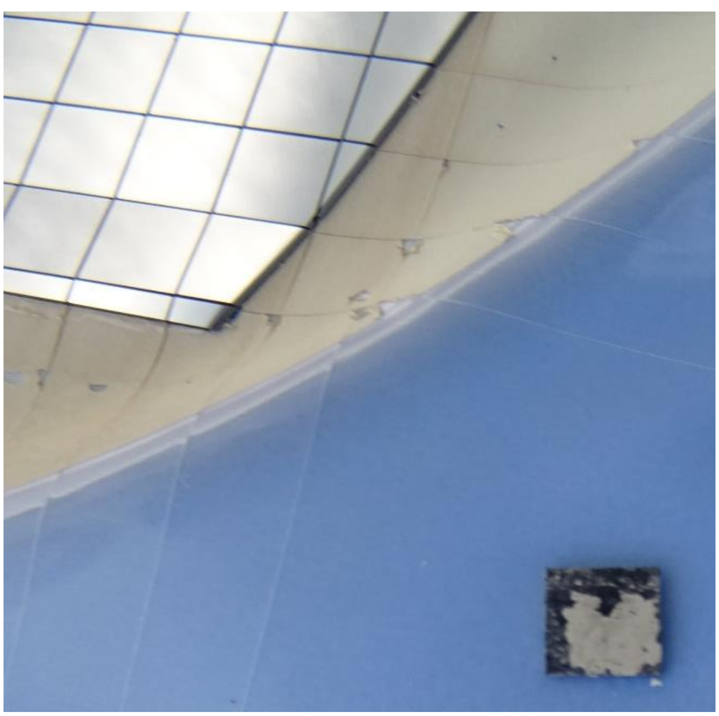

Fig.5 Adhesive presence on backside of die

Fig 6 DAF stringer

Die attach films can also be applied to non-die attach processes such as lid sealing and wafer bonding. At Quik-pak, where Open molded cavity plastic packages (OmPP) are made in array form as shown in Figure 7, various DAF materials were evaluated for sealing a large panel lid. OmPP are made by molding walls on QFN lead frames with standard thermoset mold compounds. OmPP packages can be temporarily sealed to provide engineers with the flexibility to test and debug rapidly. They can also be effectively overmolded by dispensing epoxy to fill the cavity and curing. And, these cavity packages can be lid-sealed for MEMs and sensor products. Lid sealing can be done either individually or in panel form utilizing DAF, with a preference for the latter for cost savings.

A comparison of 5 DAF types from several suppliers showed one DAF type that produced 100% yield on lid seal integrity. For each DAF type, a panel of OmPP packages, namely, QFNs, was panel lid sealed under thermal compression and then saw singulated. One DAF product yielded 108/108 pass on visual in 10X magnification with no voids on all 4 sides of the singulated QFNs. Figures 8a and 8b shows the sidewall of the ceramic lid over the QFN with a very uniform bondline of 20-25 um in thickness of DAF. 15/15 units passed after been subjected to a Fluorinert™ leak test (Mil. Std. 883 Method 1014 Condition C1) with no preconditioning to catch leakers by the presence of escaping bubbles.

Furthermore, lid shear of the lidded QFN showed high strength with adhesive fracture as revealed by adhesive residues on both lid and package surfaces Figure 9. Table 3 showed the lid shear results in excess of 10Kg for a 28 leaded OmPP QFN package.

Summary and Conclusion

In this article, DAF is shown to be well established as a standard die attach material and can also work as a lid seal material for open cavity panels. Many types of DAF, including silver filled electrically conductive, diamond filled thermally conductive as well as non-conductive DAF for various complex microelectronic assemblies have been successfully implemented.

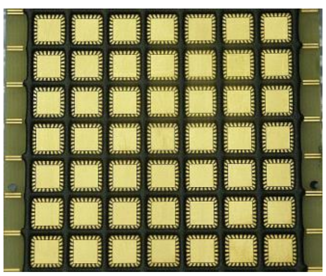

Fig 7

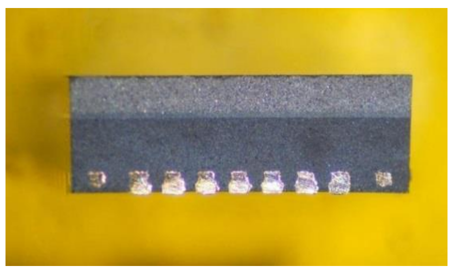

Fig 8A

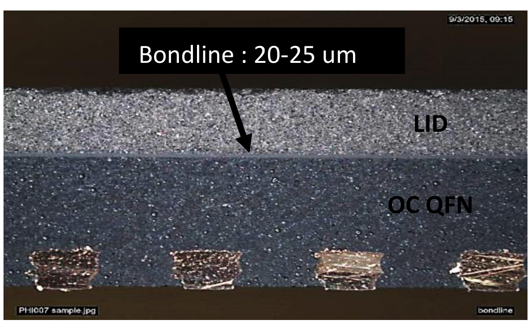

Figure 8b

Figure 9

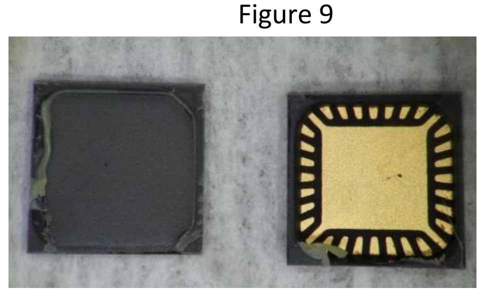

Table 3

Sample	Force (Kgf)
1	14.831
2	11.588
3	13.370

[1] "Delamination from Process Induced Sources" A. Teng C., IEEE Electronic Component & Technology Conference, San Diego, June 1-4, 1999

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