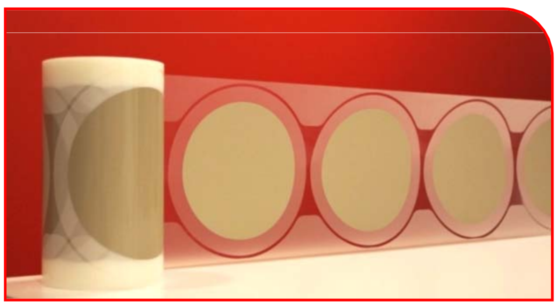
Conductive Die Attach Film - CDAF

Higher Reliability Conductive Die Attach Films: Compatible with Si and GaAs Wafers

MEPTEC Luncheon – December 11th 2013



Presented by Shashi Gupta

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4. Bulk vs In-package measurements
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8. Summary

Market Trends

Smaller, Faster, Higher Functionalities

- Higher density design
- Higher functionalities
- Faster signal speed
- Power Management
- Lower TCoO
- Reduce package thickness

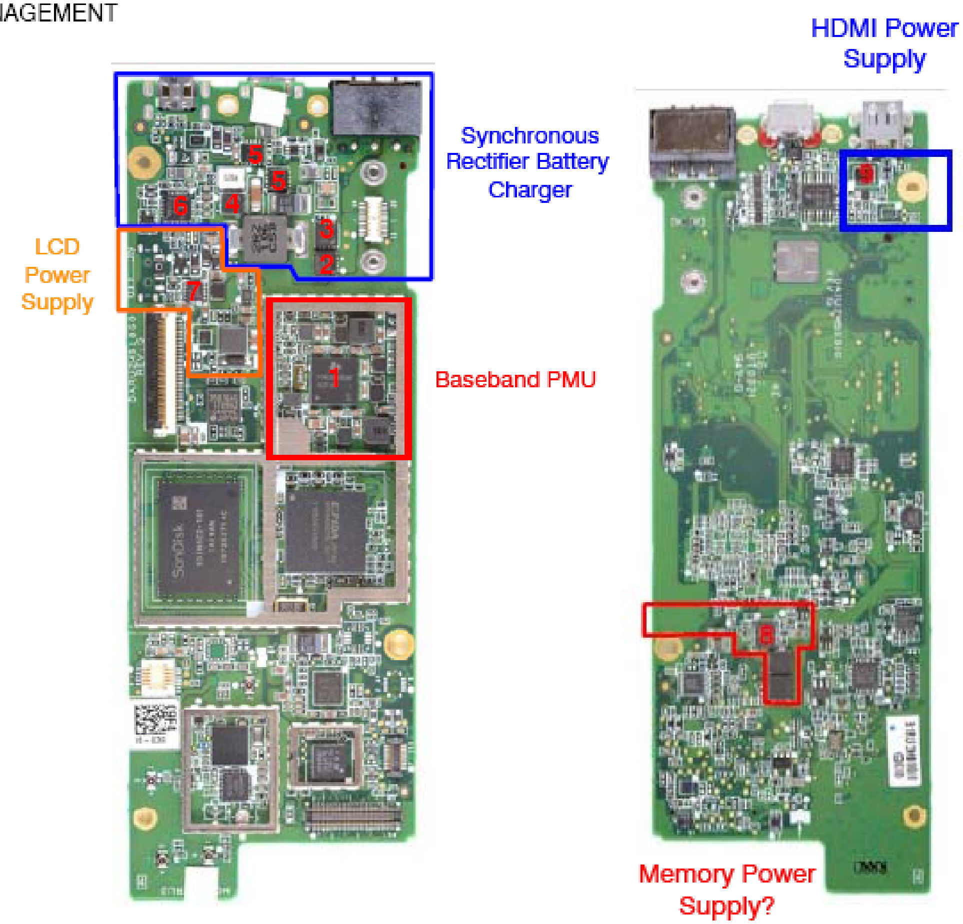
Applications space covers consumer, mobile, computing, communication health care, energy, industrial and automotive.

Market Trends

An Example – Source Prismark

RIM PLAYBOOK POWER MANAGEMENT

1. Texas Instruments TWL6030 Power Manager
   - 256-CSP
2. TI/CICLON CSD25401 P-Channel NexFET Power MOSFET
   - QFN3.3x3.3
3. Fairchild FDMC510P P-Channel PowerTrench MOSFET
   - QFN 3.3x3.3
4. Fairchild FDMC7200 Power Trench MOSFET "non catalogue"
5. Alpha and Omega AON740130V P-Channel MOSFET
   - DFN 3x3mm
6. Intersil ISL9519 Highly Integrated Narrow VDC System Voltage Regulator and Battery Charger controller
   - QFP-28
7. Texas Instruments TPS63031 High Efficient Single Inductor Buck-Boost Converter w/1-A Switches
   - QFN-10
8. Texas Instruments PS63020 High Efficiency Single Inductor Buck-Boost Converter with 4A Switch
   - QFN-14
9. Texas Instruments TPD12SO15YFFR HDMI Companion Chip with Step-up Converter, 12C Level Shifter, and High-speed ESD Clamps
   - WSCSP-28



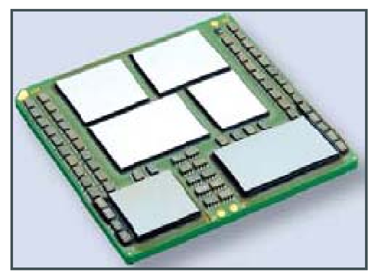
Package Trends - Wirebonded

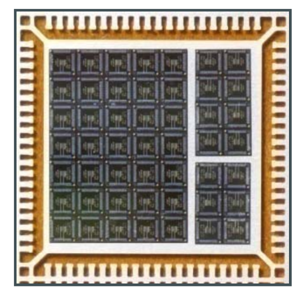
Higher Functionality & Efficiency

- Miniaturized packages (QFN, DFN, SOs)
  - Increased die-to-pad ratio
  - In some case D/P ratio close to 1.0

- Thinner packages (QFN, SO, QFP)
  - Packages <0.3mm
  - Thinner die <75um
  - Thinner DA bondline thickness <20um

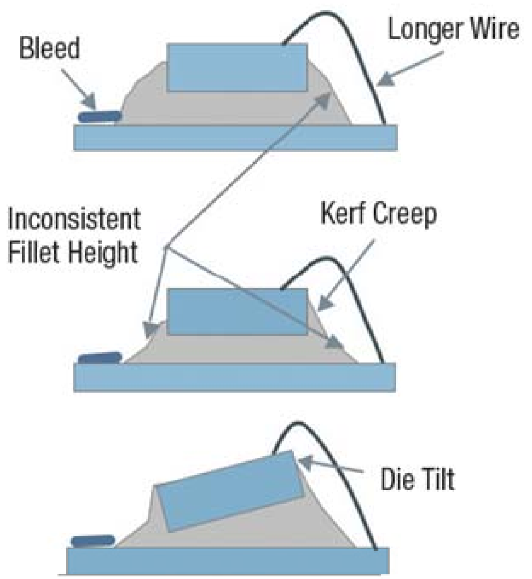
- Higher density packages
  - Multi-dies packages
    - SiP – LGA/PBGA

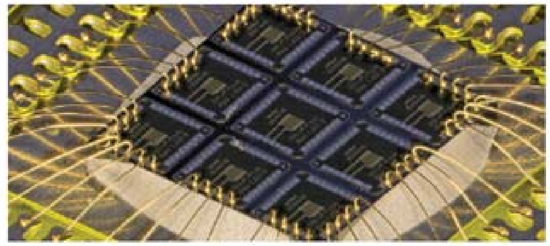




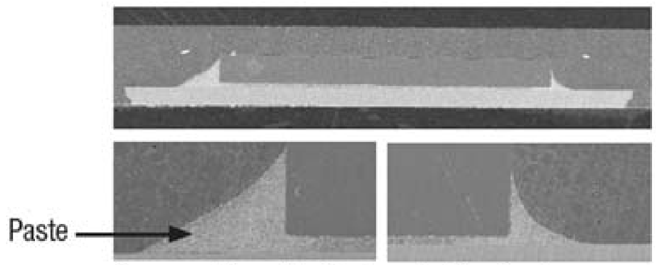
Current Material Challenges on LFs

Conducting Die Attach Paste

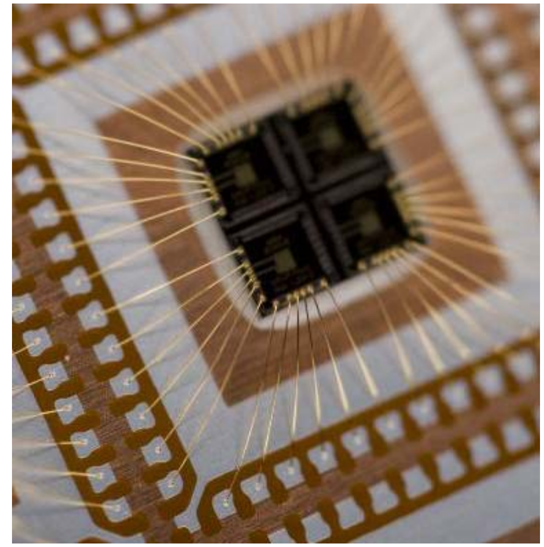




Typical paste-based die attach.



Cross section of typical paste die attach.



- **Dispensing:** Optimize dispense patterns for various die sizes - 0.2 x0.2 mm to >10x10mm.
- **Fillet & Bleed:** Forces engineers to have a minimum keep out zone around die
- **Bondline Control:** Specially for smaller die BLT control is challenging and leads to die tilt
- **Kerf creep:** For thinner wafers uneven fillet height can lead to kerf creep

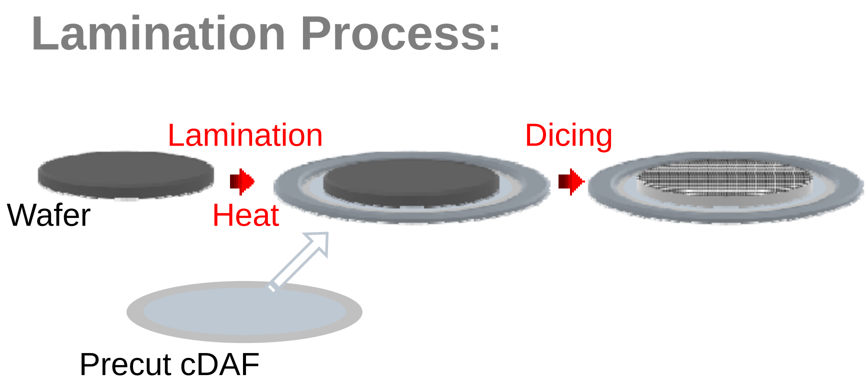
Future Material Needs

What does the market really need moving forward ?

- Lower Cost
- Higher Reliability
- Zero Delamination
- Zero Bleed
- Minimal fillet
- Consistent BLT control
- Thin Wafer handling capability
- Low to no outgassing
- Drop in solution

New Materials – Conductive Die Attach Films

Controlled flow technology

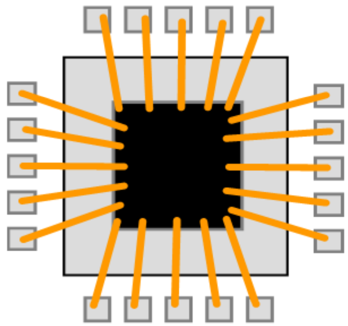


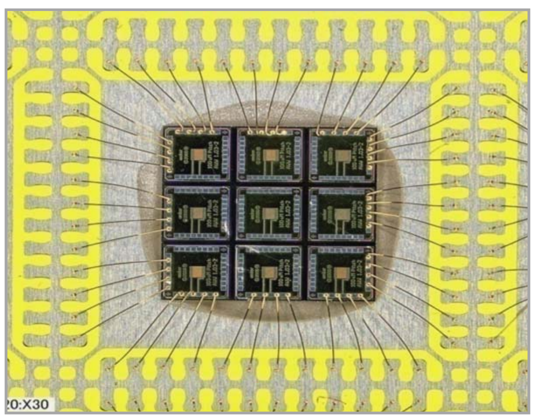
Precut conductive die attach films offer
a single step lamination to wafer back

Control Flow

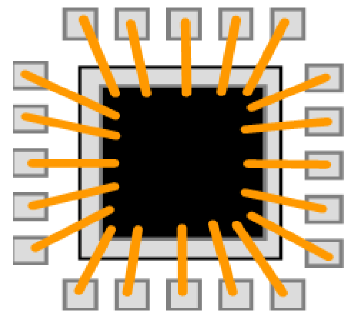
Enables Miniaturization

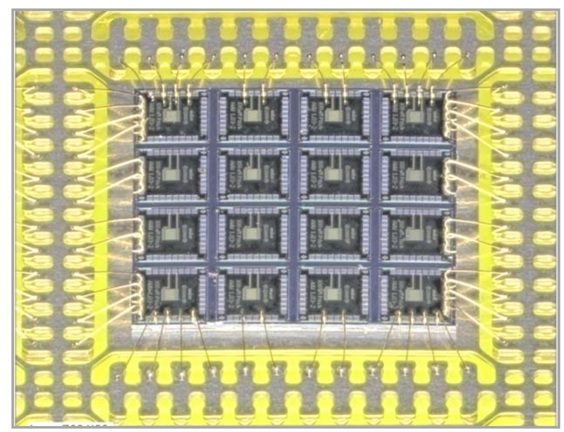
With Fillet





Controlled Fillet





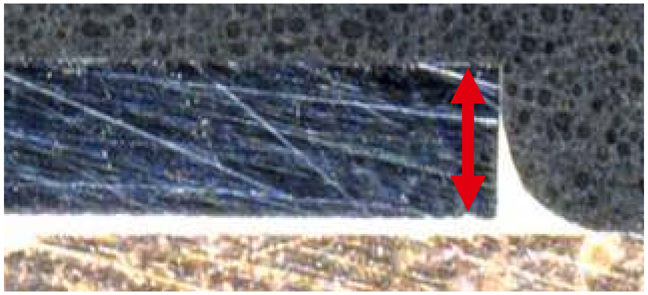
Reduced footprint → Shorter interconnection → Faster signal speed

Less Au wire, leadframe, EMC used → Lower TCoO

Control Flow

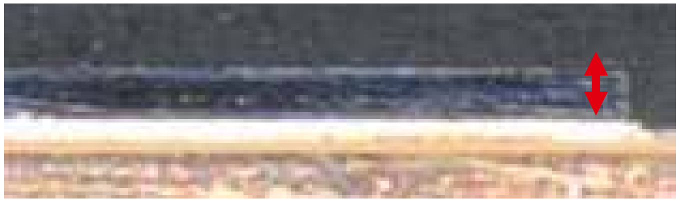
Thin Wafer Handling

Package with Fillet



Die Attach Paste

Controlled Fillet Height



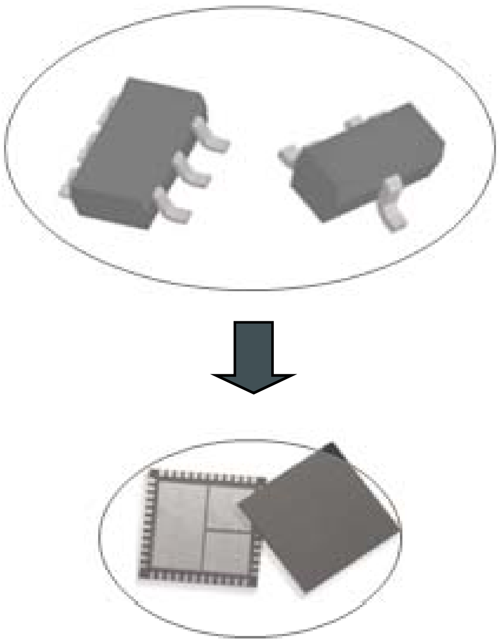
Die Attach Film

- Thinner wafer handling enabled
- Consistent Thinner bondlines achieved
- Eliminated Fillet
- Eliminated bleed

Advantages of Control Flow

Package level

- **Enables emerging packages:**
  - Miniaturized
  - High density
  - Ultra thin
- **Indirectly improves package performance:**
  - Faster signal speed (shorter interconnection)
  - Better power management (low RdSon)
  - Better heat dissipation
- **Indirectly reduces TCoO:**
  - Cheaper design choice (SiP vs. SoC)
  - Less material used (high packaging density)
  - Improve yield

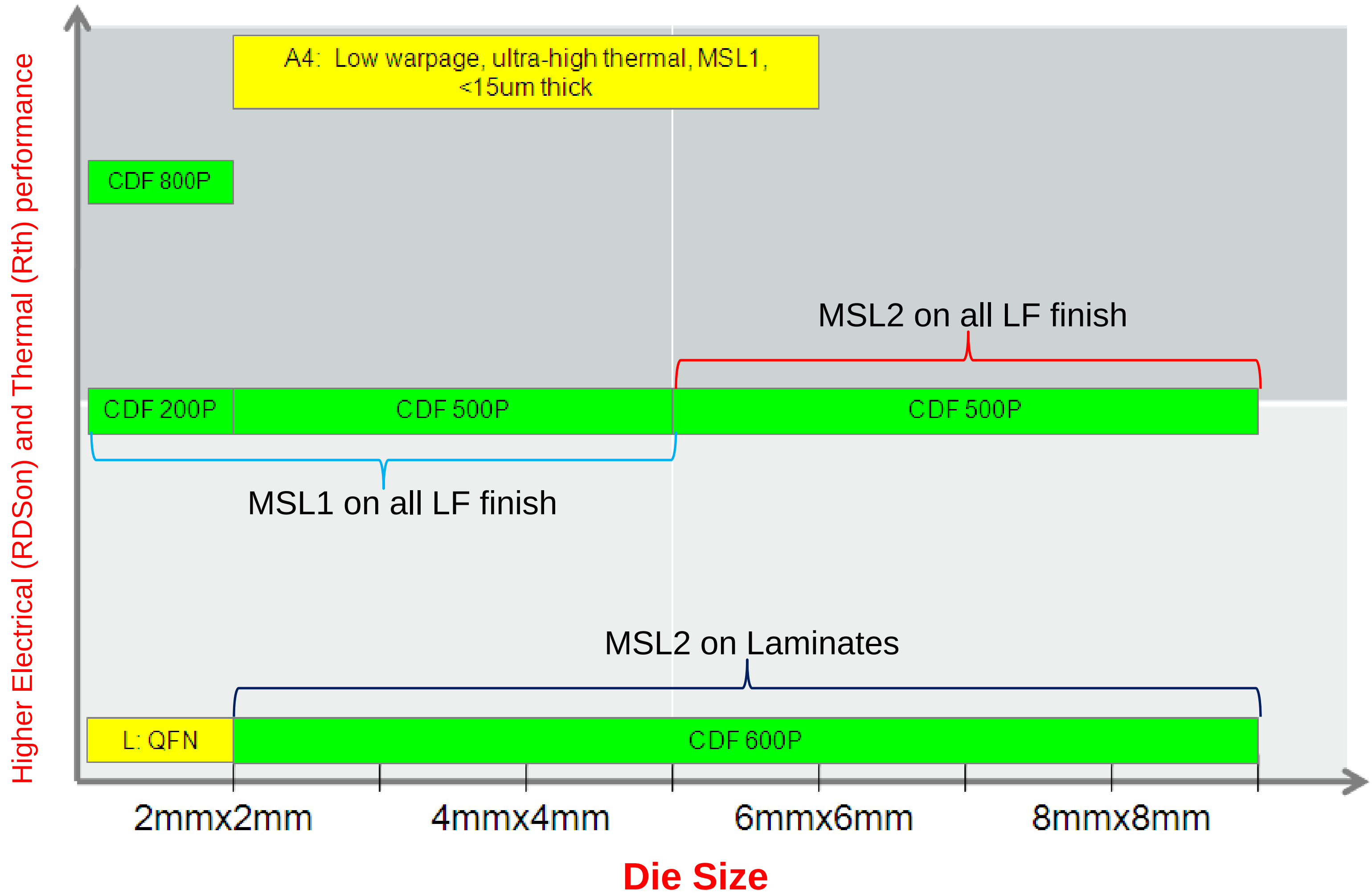


Footprint reduction (>50%):
Multiple packages to one
using multiple die.

CDAF technology is well-aligned with emerging package trends

Henkel's Solution to Control Flow

Product Space



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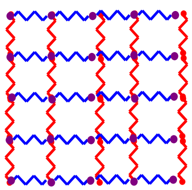
Why CDAF has higher reliability

Paste and Film comparison

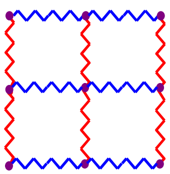
Paste material
Low viscosity
Thermoset monomer with lower molecular weight



High cross-linking density
Low toughness

Lower adhesion
Inferior MSL performance

Film material
High viscosity
Thermoset monomer with higher molecular weight (solid resins)

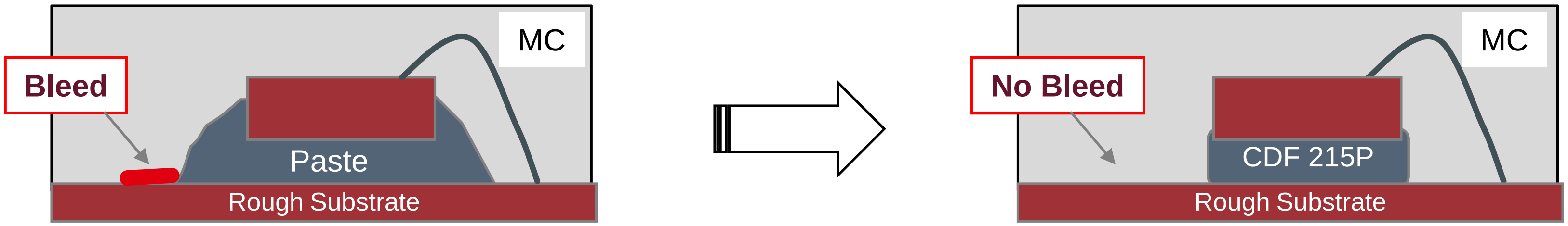


Lower crosslinking density
High toughness

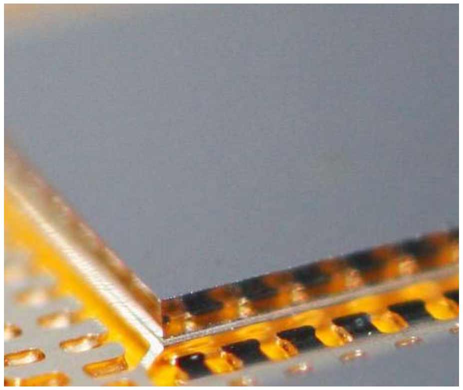
Better adhesion
Better MSL performance

Material Benefits of cDAF

Potential for Zero Delam applications

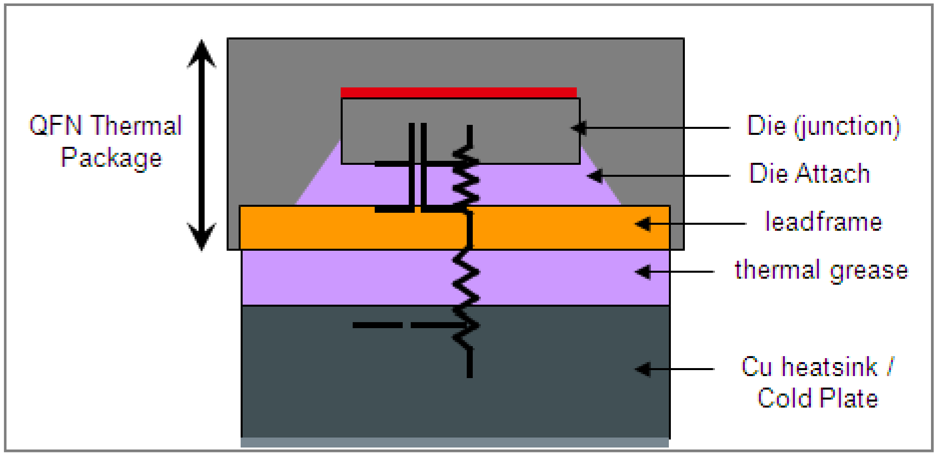


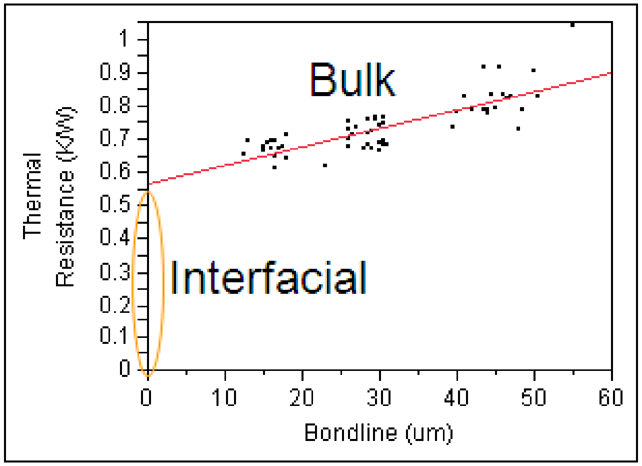
- Conductive films do not bleed and do not have a fillet, so the adhesion of MC to LF is stronger – regardless of LF finish: smooth or rough.
- CDAF also has minimal out-gassing, which ensures clean WB bond pads & die top –
  - wirebonding or MC-die top delamination not observed



Thermal & Electrical for cDAF

Stable In-Package performance





- Thermal Conductivity [W/mK] is an intrinsic material property
- Thermal Resistance, R_{th} [K/W], is a geometry dependant value that allows us to better compare materials in a functional package
    - 70 – 90% of the R_{th} is due to the interfaces and is not captured in thermal conductivity values

Conductive films are designed to have optimal performance in the z-axis direction

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Portfolio of CDAF Products

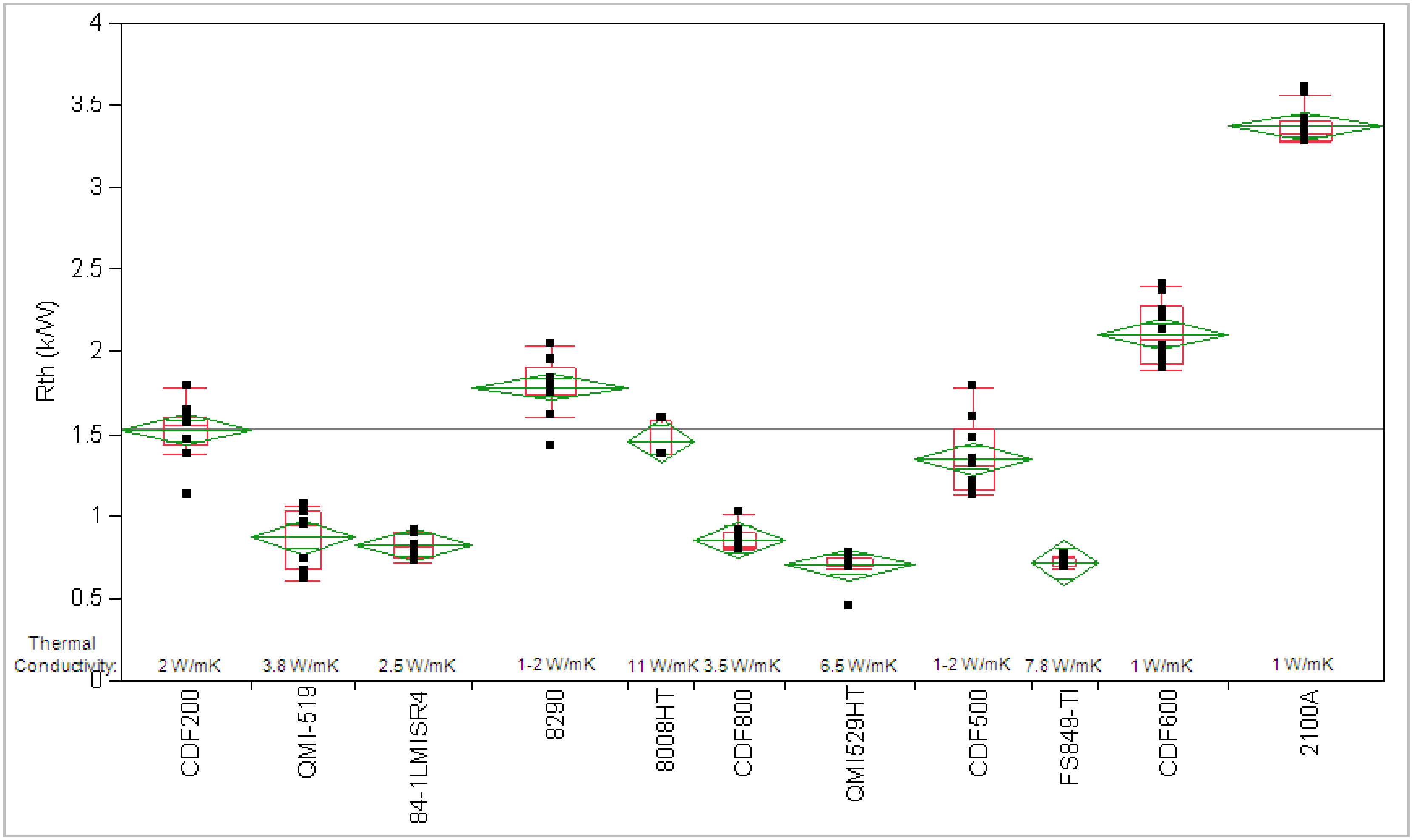
Property table for film and paste

	unit	CDF 200P	QMI519	84-1LMI SR4	8290	8008HT	CDF 800P	QMI529HT	CDF 500P	FS849-TI	CDF 600	2100A
Material Property												
Volume Resistivity	ohm-cm	0.0014	0.0001	0.0002	0.008	0.00006	0.0003	0.00004	0.0002	0.00002	0.0008	0.05
Thermal conductivity	W/mK	2	3.8	2.5	1.6	11	3.5	6.5	1 - 2	7.8	1	1.35
CTE alpha1	ppm/C	48	40	40	81	37	40	53	60	44	75	65
CTE alpha 2	ppm/C	120	140	150	181	62	118	156	245	155	320	200
Tg	°C	15	75	120	38	264	11	3	10	211	"-5	60
Modulus @ 25C	Mpa	5,400	5,300	3,930	3,034	6,659	7,100	3,300	11,300	7,800	3,000	3,200
Modulus @ 250C	Mpa	1,000	287	303	117	2,450	900	-	130	1,070	40	230
Performance												
HDSS (260°C) on Ag	kg/mm^2	1.3	0.8	0.2	0.6	0.7	1.0	0.5	0.7	0.5	0.7	0.4
Room Temp DSS on PPF	kg/mm^2	2.14	4.9	3.0	5.0	-	> 2.0	-	-	-	-	-
Room Temp DSS on Ag	kg/mm^2	3.02	4.8	2.3	5.1	1.5	> 2.0	2.2	-	-	-	-
Room Temp DSS on Cu	kg/mm^2	3.17	1.8	1.2	2.5	1.5	> 2.0	-	-	-	-	-
Failure Mode		Cohesive	Cohesive	Cohesive	Cohesive	-	Cohesive	Cohesive	Cohesive	-	Cohesive	Cohesive
Thermal Resistance, Rth	K/W	1.5	1.3	0.83	1.8	1.5	0.81	0.77	1.5	0.72	2.1	2.3
RDSon	ohm	0.075	0.044	0.033	n/a	0.067	0.032	0.042	0.055	0.038	n/a	n/a
RDSon Shift (500 TC)	%	2.2	n/a	10.0	n/a	n/a	5.7	42	n/a	28.0	n/a	n/a
RDSon Shift (1000 TC)	%	6.6	n/a	15.6	n/a	n/a	6.4	42	n/a	28.8	n/a	n/a
JEDEC MSL 260°C (on 7x7mm PPF QFN with 2.5x2.5x0.33 die)	MSL level	1	MSL1 capable for small die	3	MSL1 capable for small die	3	1	MSL1 capable for small die	1	MSL1 capable for small die	2 (PBGA)	2 (PBGA)
JEDEC MSL 260°C (on 7x7mm PPF QFN with 5x5x0.36 die)	MSL level	2	-	-	-	-	2	-	1	3	2 (PBGA)	2 (PBGA)
Processing												
Cure	profile	30 min ramp to 200C + 1hr soak @ 200C	30 min. ramp + hold 60 min @ 100°C + 15 min ramp + hold 60 min @ 200°C.	30 min ramp to 175C + 1hr soak @ 175C	30 min ramp to 175C + 15min soak @ 175C	20 seconds @ 280°C	30 min ramp to 200C + 1hr soak @ 200C	30 min ramp to 185C + 30 min soak @ 185C	30 min ramp to 200C + 1hr soak @ 200C	30 min ramp to 175C + 30 min soak @ 175C	30 min ramp + 100C/30min + 30 min ramp + 170C/1hr	30 min ramp to 175C + 15min soak @ 175C

Thermal Resistance

Comparison of paste and film materials

2.5x2.5x0.36mm² Si-back die
QFN 7x7mm, PPF (pad 5.8x5.8mm)
30min RAMP + 200°C 1hr cure



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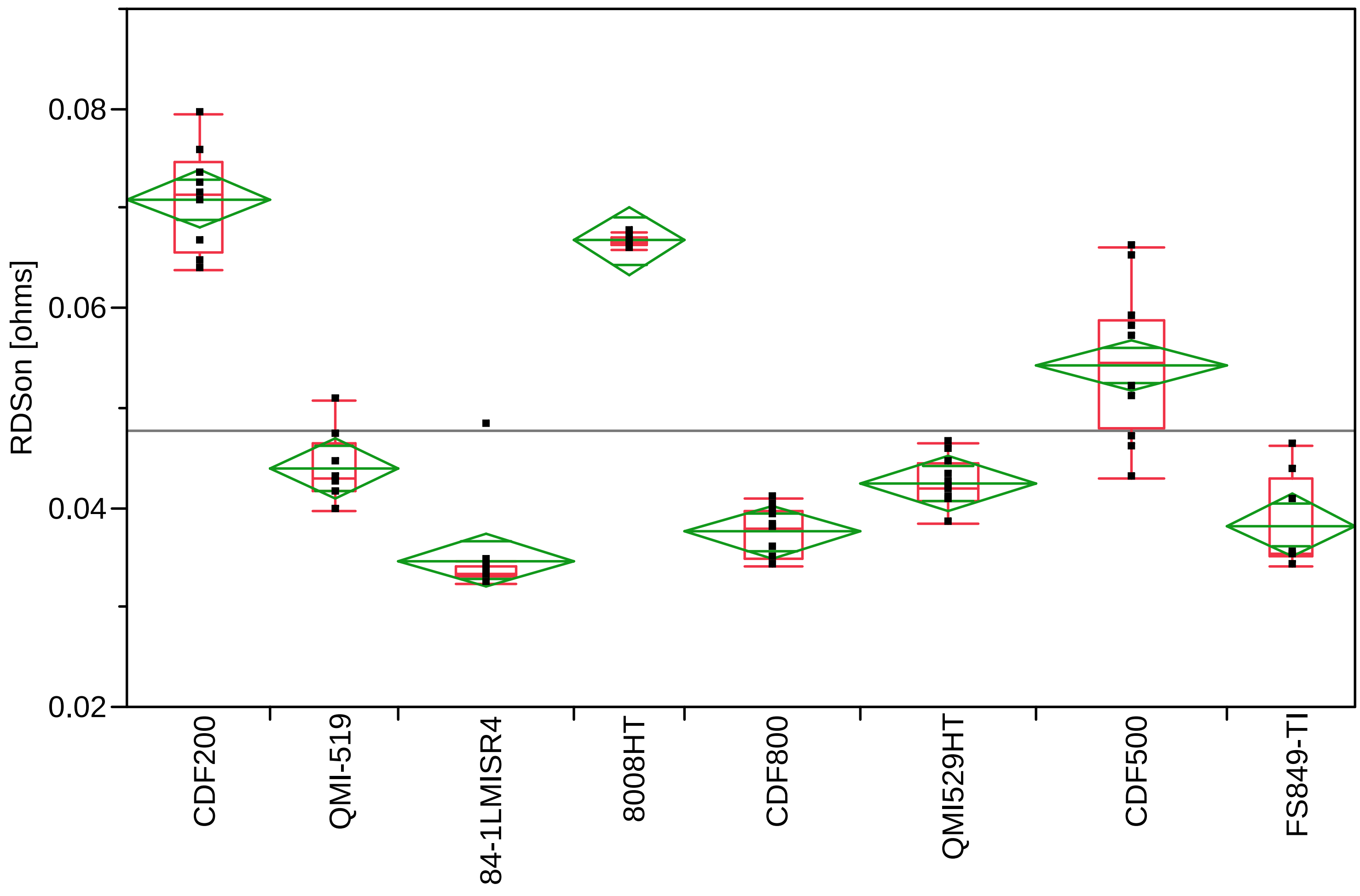
RDSon

In package performance

2.0x2.9x0.18mm; TiNiAg-back die
TO-220, Cu pad



Conductive Die attach Film

Laser Dicing

	Blade Dicing	Laser Dicing
Process method	Mechanical cutting	Surface absorption laser process (melting, evaporation)
Water (cooling / cleaning)	Required	Required for cleaning only
Chipping?	Yes	Less chipping
Debris generation?	Yes	Yes
T-shape and round shape dicing	Not possible	Possible in certain cases
Ultra-thin wafer dicing possible?	Limited	Possible
Kerf Width	15 to 25 µm	Less than 15µm
Processing speed	5 to 10 mm/s	225 mm/s

CDAF is compatible with both blade and laser dicing on Si or GaAs waders

Advantages of Control Flow

CDAF – Material Advantages

- **Thin wafer handling with precut format**
  - Excellent electrical conductivity, very low RDSon shift (<10%)
  - Thinner package and smaller footprint (higher density packaging)
  - Potentially eliminate wafer backside metallization
  - In multi-die packages allow shorter die-to-die wirebonds for faster speeds.

- **Consistent bondline thickness and controlled flow**
  - No die tilt,
  - Design flexibility from tight clearance between die and die pad
- **Clean dry process**
  - No dispensing, printing/B-staging necessary
  - No bleed (even on rough LFs), no fillet, uniform bondline, no kerf creep

- **Reliability performance**
  - Higher reliability performance (MSL1) on mulitiple substrates (PPF, Ag Spot, Cu) and various wafer back metallization (Si, Au, Ag)
  - Achieve better efficiency, reduce yield loss: Efficient and robust process

- **Cost Savings**
  - Higher density leadframes, shorter Au wires and less mold compound usage

Thank you!

Henkel Electronics Adhesives Headquarters

Irvine, California

Alan Syzdek
Corp Sr. Vice President

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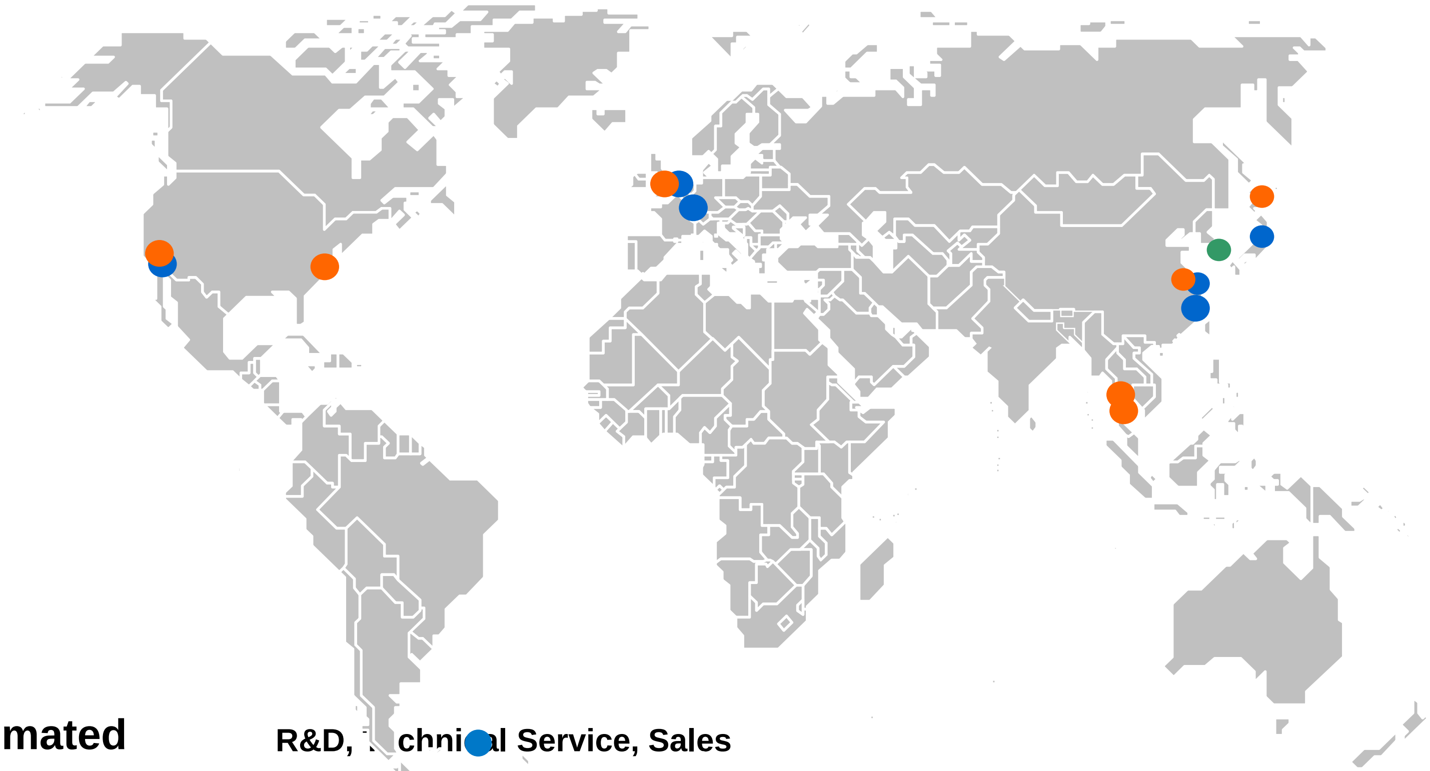

Estimated Employees: 1,700

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- **Globally aligned infrastructure to serve our customers locally.**

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