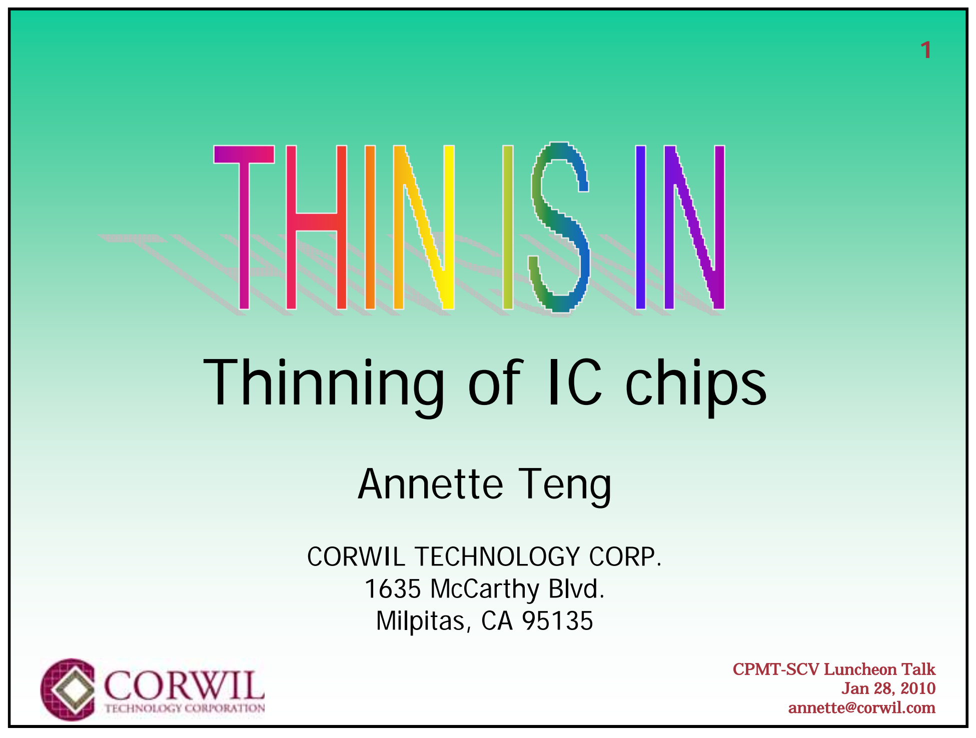

2

CONTENT
- Industry Demand for thinness
- Method to achieve ultrathin dies
- Mechanical testing of ultrathin die
- Die strength variation source
- Methods to achieve strong ultrathin dies
- Assembly of Ultrathin dies
  - Die Attach Films
  - Interconnection

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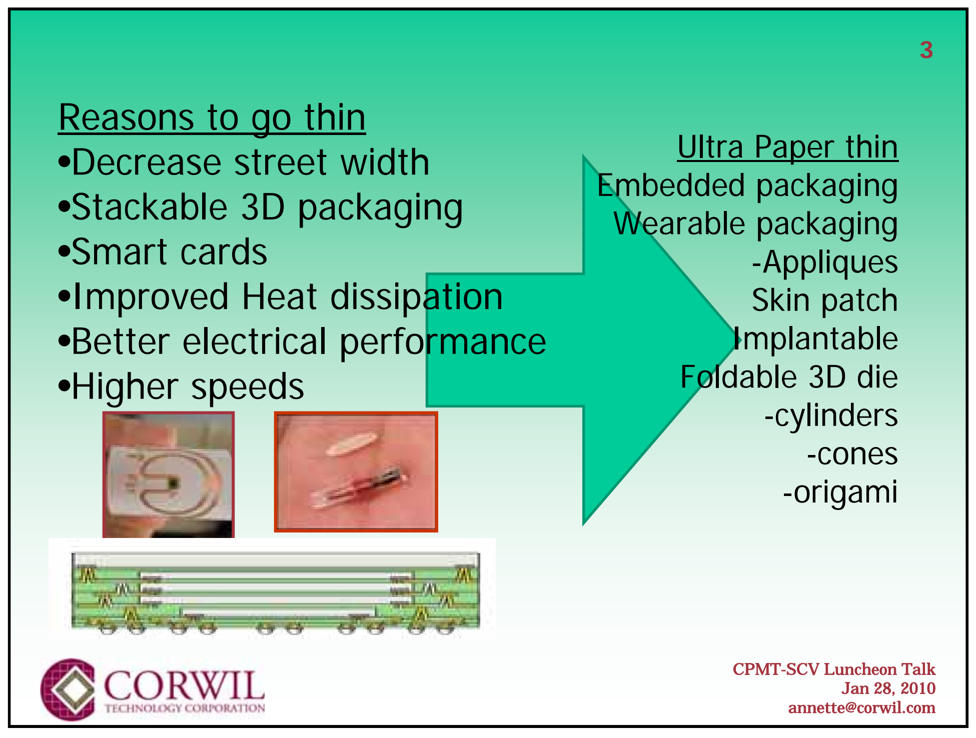
3
Reasons to go thin
•Decrease street width
•Stackable 3D packaging
•Smart cards
•Improved Heat dissipation
•Better electrical performance
•Higher speeds
Ultra Paper thin
Embedded packaging
Wearable packaging
-Appliques
Skin patch
Implantable
Foldable 3D die
-cylinders
-cones
-origami
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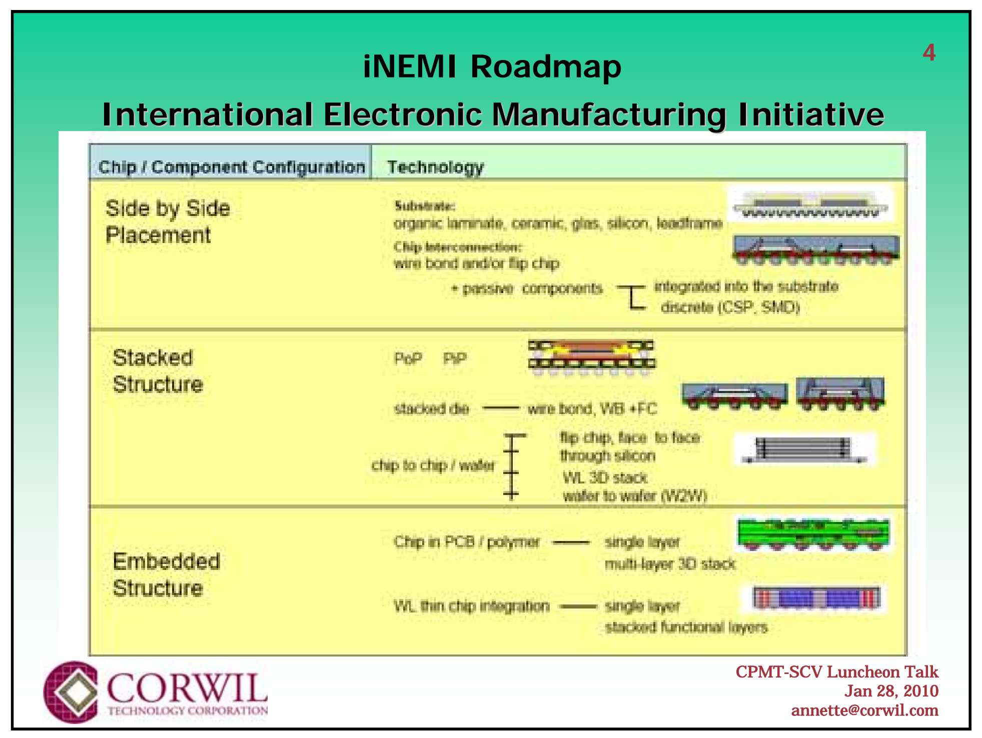
4
iNEMI Roadmap
International Electronic Manufacturing Initiative
Chip / Component Configuration
Technology
Side by Side Placement
Substrate:
organic laminate, ceramic, glas, silicon, leadframe
Chip Interconnection:
wire bond and/or flip chip
+ passive components
integrated into the substrate
discrete (CSP, SMD)
Stacked Structure
PoP PiP
stacked die
wire bond, WB +FC
chip to chip / wafer
flip chip, face to face
through silicon
WL 3D stack
wafer to wafer (W2W)
Embedded Structure
Chip in PCB / polymer
single layer
multi-layer 3D stack
WL thin chip integration
single layer
stacked functional layers
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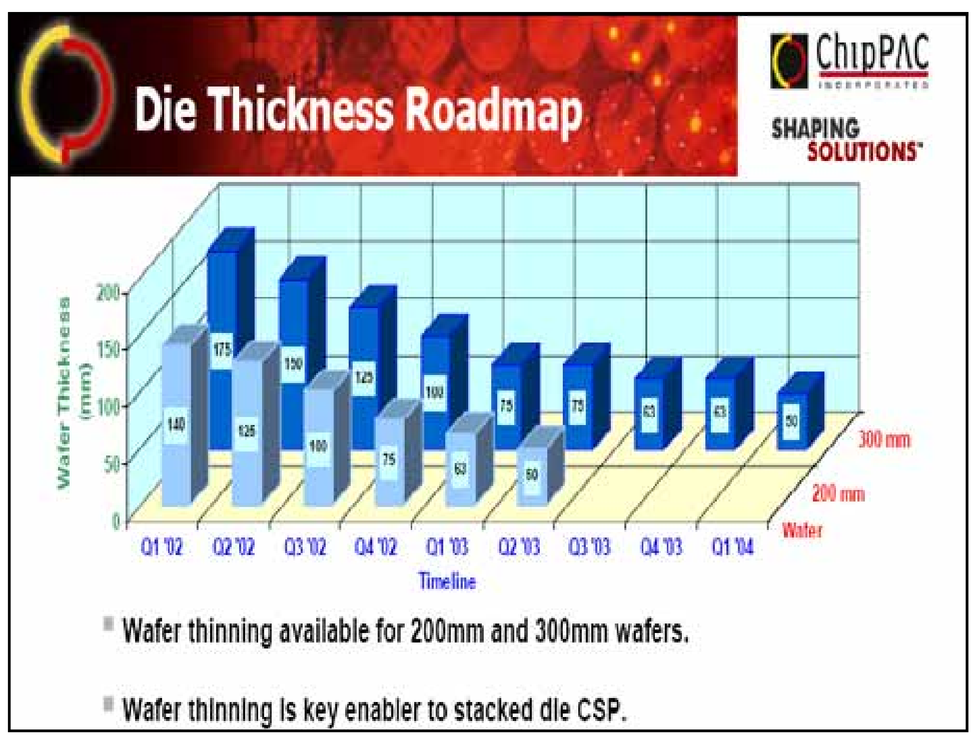
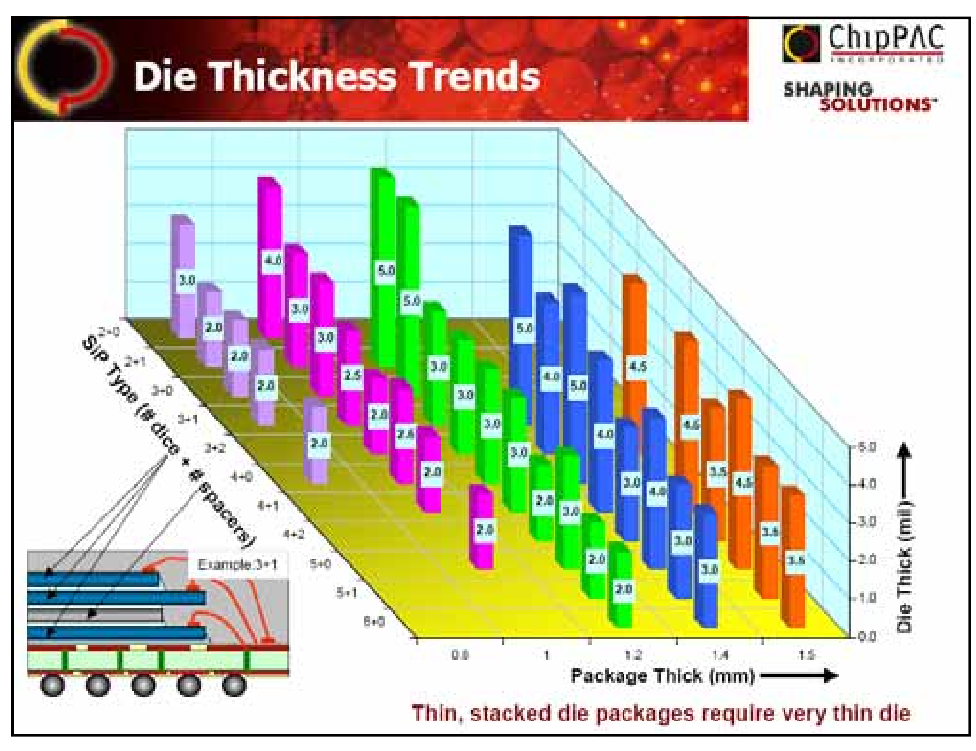
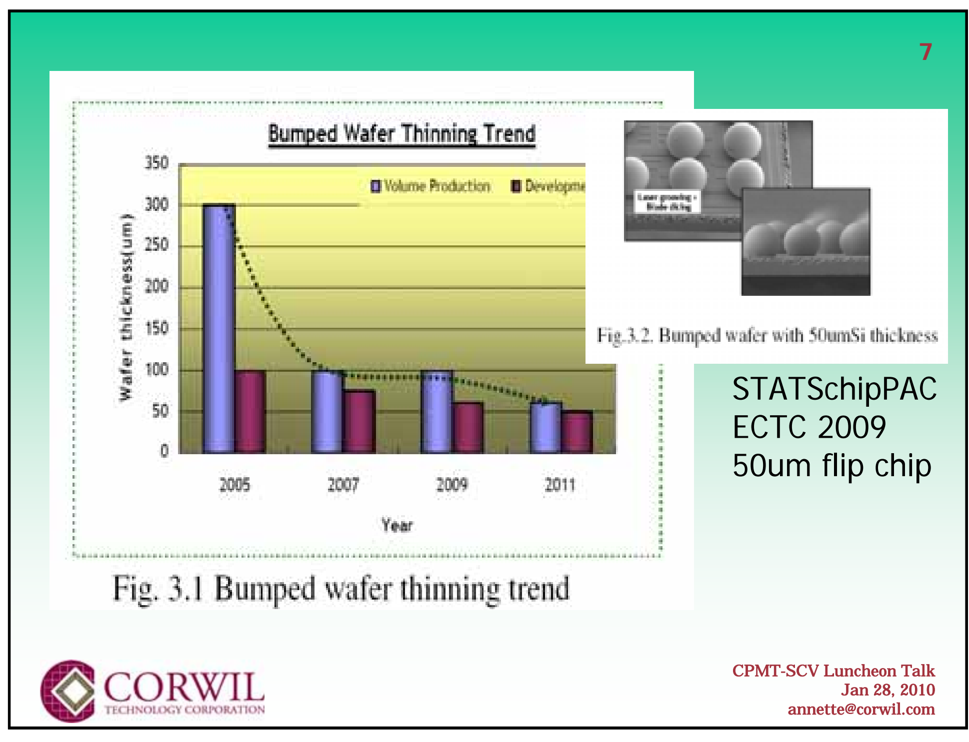

Die Thickness Roadmap
ChipPAC
SHAPING SOLUTIONS
Wafer Thickness (mm)
Timeline
Q1 '02 Q2 '02 Q3 '02 Q4 '02 Q1 '03 Q2 '03 Q3 '03 Q4 '03 Q1 '04
300 mm
200 mm
Wafer
Wafer thinning available for 200mm and 300mm wafers.
Wafer thinning is key enabler to stacked die CSP.


Die Thickness Trends
ChipPAC
SHAPING SOLUTIONS
SiP Type (# dice + # spacers)
Example:3+1
Package Thick (mm)
Die Thick (mil)
Thin, stacked die packages require very thin die


7
Bumped Wafer Thinning Trend
Volume Production
Wafer thickness(um)
350
300
250
200
150
100
50
0
2005
2007
2009
2011
Year
Fig. 3.1 Bumped wafer thinning trend
Fig.3.2. Bumped wafer with 50umSi thickness
STATSchipPAC
ECTC 2009
50um flip chip
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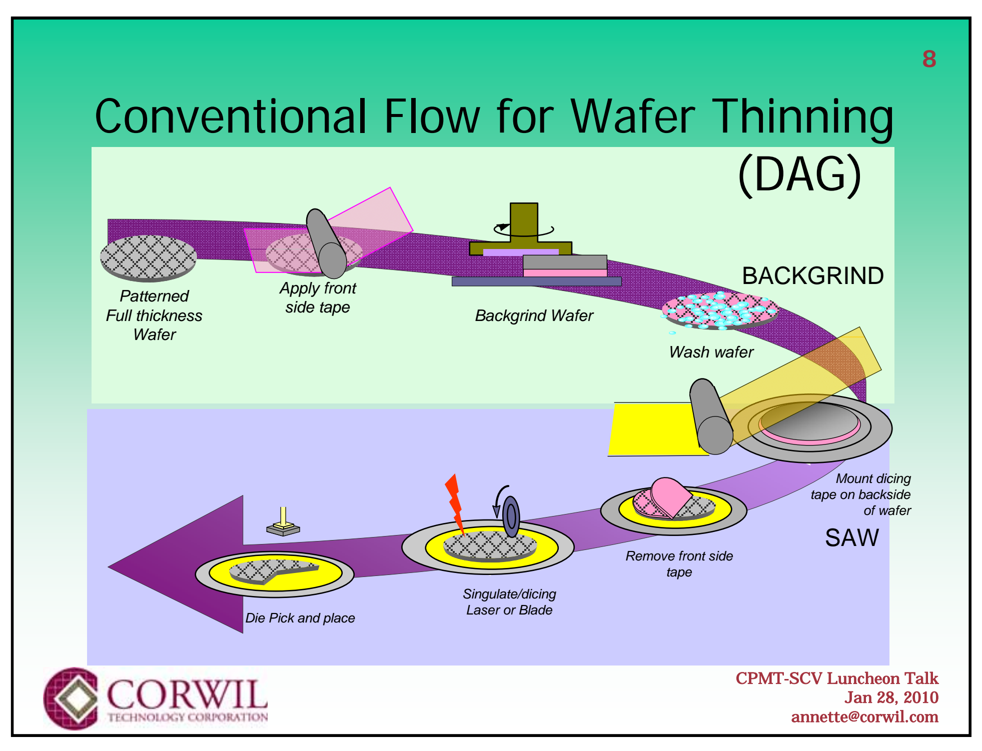
8
Conventional Flow for Wafer Thinning (DAG)
Patterned Full thickness Wafer
Apply front side tape
Backgrind Wafer
BACKGRIND
Wash wafer
Mount dicing tape on backside of wafer
SAW
Remove front side tape
Singulate/dicing Laser or Blade
Die Pick and place
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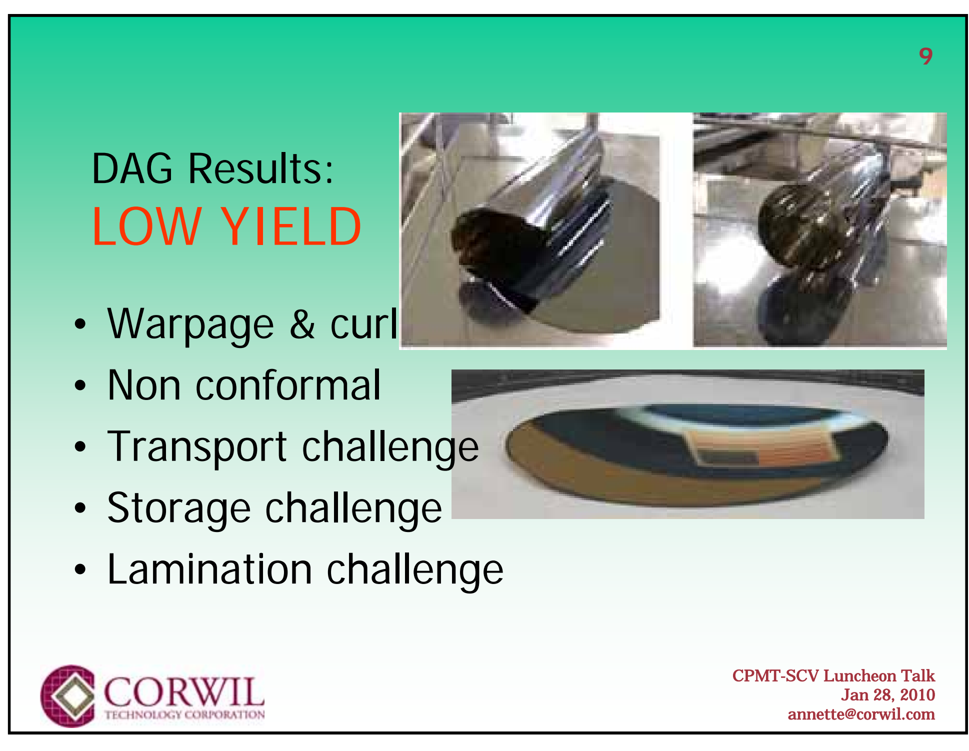
9
DAG Results:
LOW YIELD
• Warpage & curl
• Non conformal
• Transport challenge
• Storage challenge
• Lamination challenge
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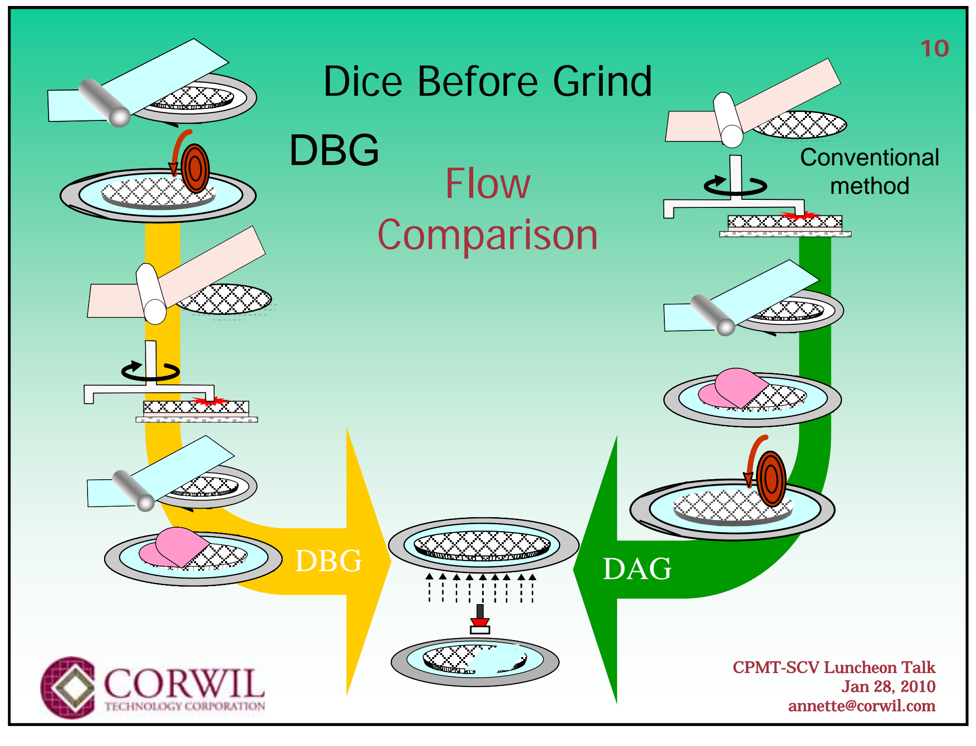
10
Dice Before Grind
DBG
Flow
Comparison
Conventional
method
DBG
DAG
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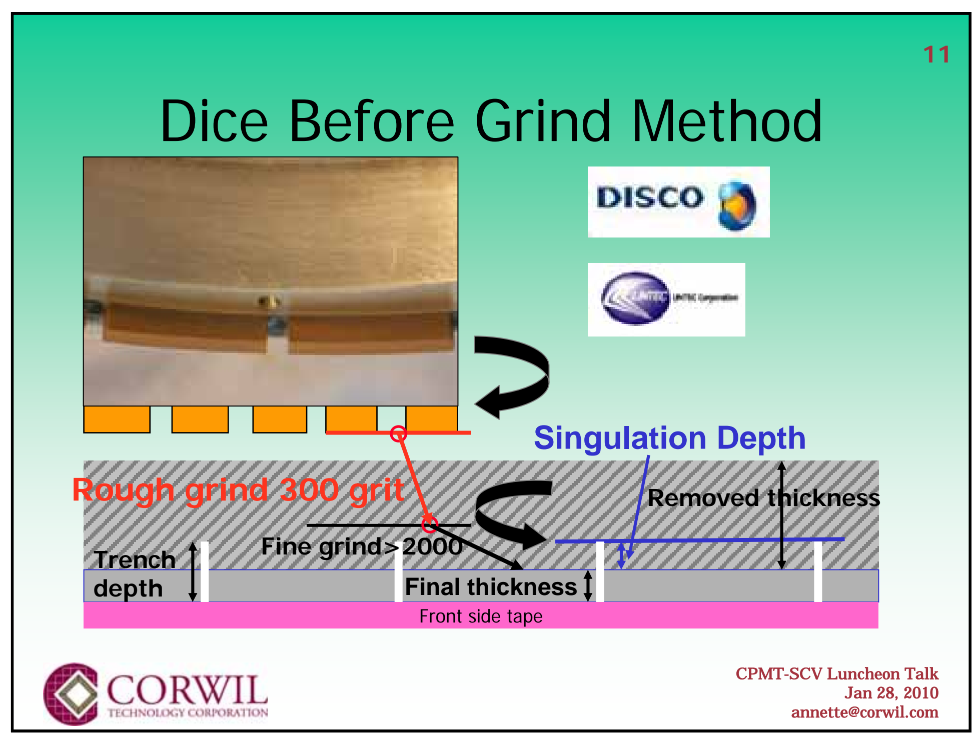
11
Dice Before Grind Method
DISCO
Singulation Depth
Rough grind 300 grit
Removed thickness
Trench depth
Fine grind>2000
Final thickness
Front side tape
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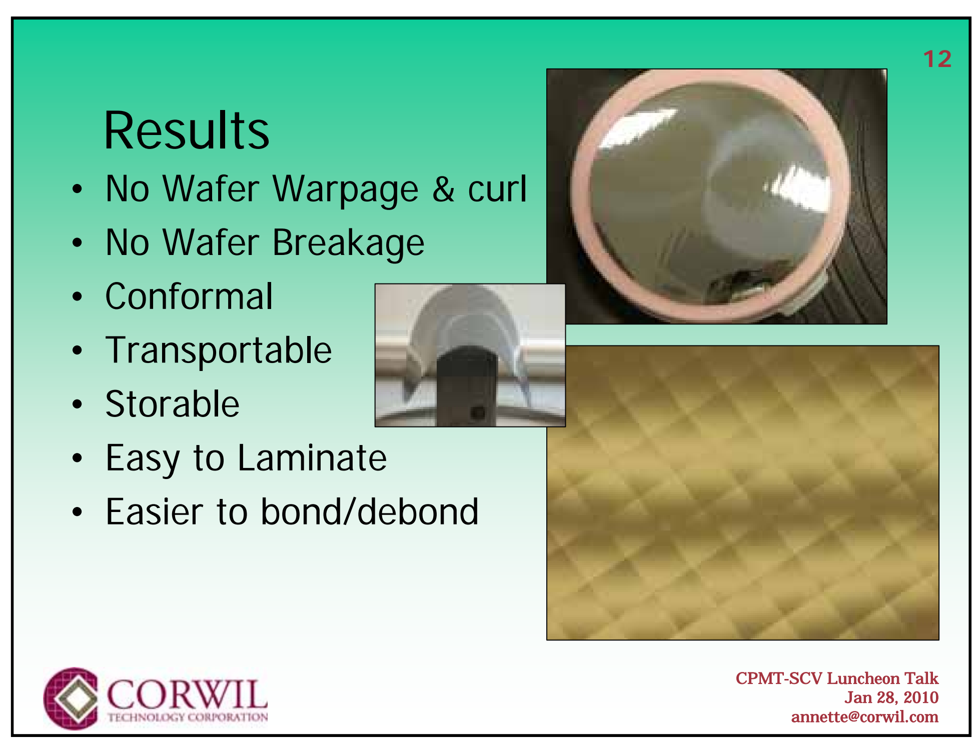
12
Results
• No Wafer Warpage & curl
• No Wafer Breakage
• Conformal
• Transportable
• Storable
• Easy to Laminate
• Easier to bond/debond
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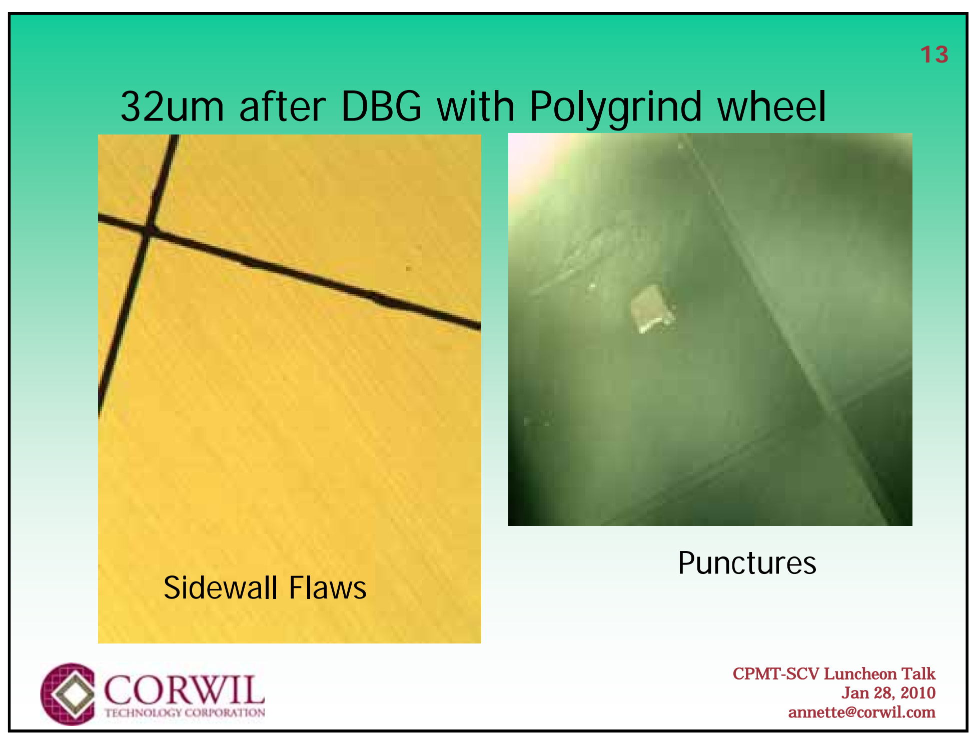
13
32um after DBG with Polygrind wheel
Sidewall Flaws
Punctures
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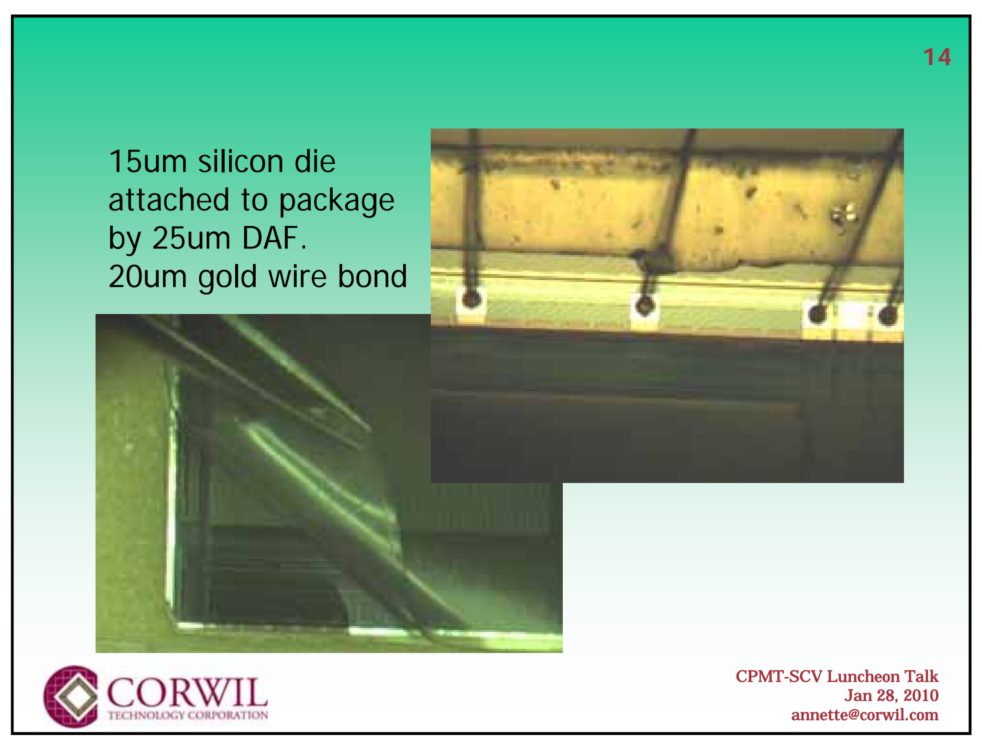
14
15um silicon die
attached to package
by 25um DAF.
20um gold wire bond
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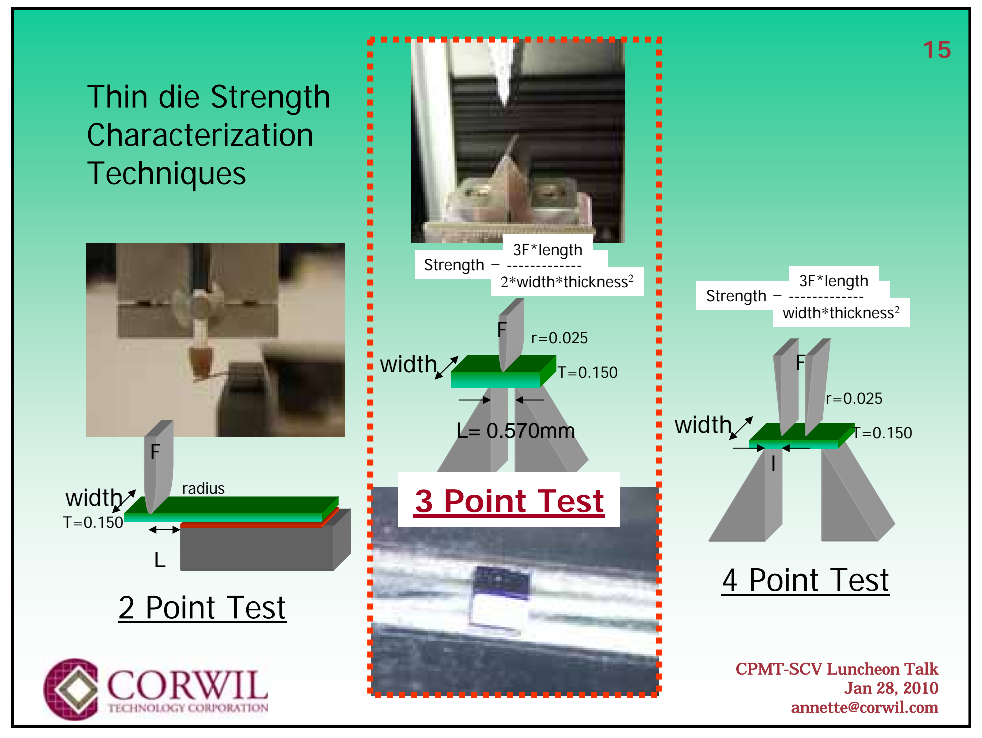
15
Thin die Strength Characterization Techniques
F
width
radius
T=0.150
L
2 Point Test
Strength = 3F*length / 2*width*thickness²
F
r=0.025
width
T=0.150
L= 0.570mm
3 Point Test
Strength = 3F*length / width*thickness²
F
r=0.025
width
T=0.150
l
4 Point Test
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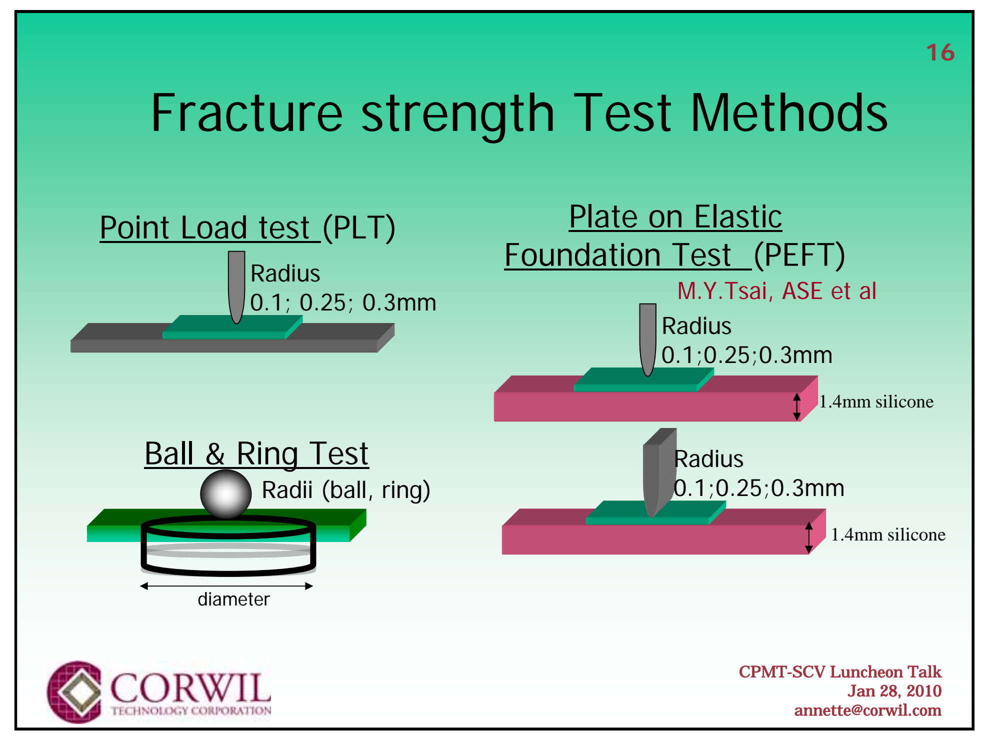
16
Fracture strength Test Methods
Point Load test (PLT)
Radius
0.1; 0.25; 0.3mm
Plate on Elastic Foundation Test (PEFT)
M.Y.Tsai, ASE et al
Radius
0.1;0.25;0.3mm
1.4mm silicone
Ball & Ring Test
Radii (ball, ring)
diameter
Radius
0.1;0.25;0.3mm
1.4mm silicone
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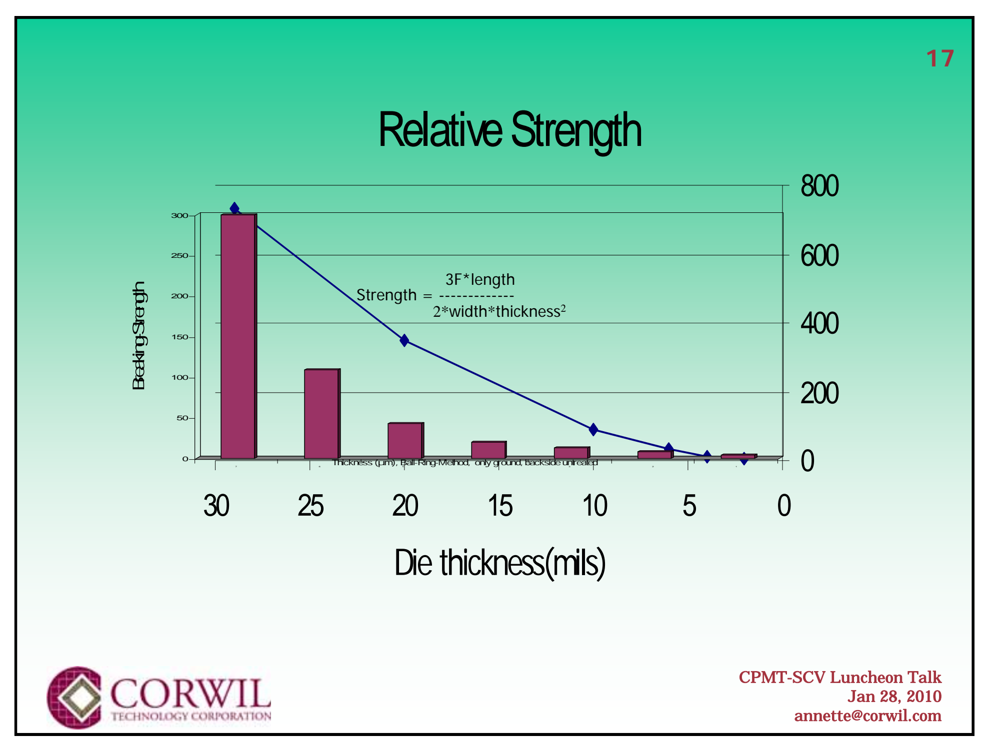
17
Relative Strength
Breaking Strength
300
250
200
150
100
50
0
800
600
400
200
0
Strength = 3F*length / 2*width*thickness²
30
25
20
15
10
5
0
Die thickness(mils)
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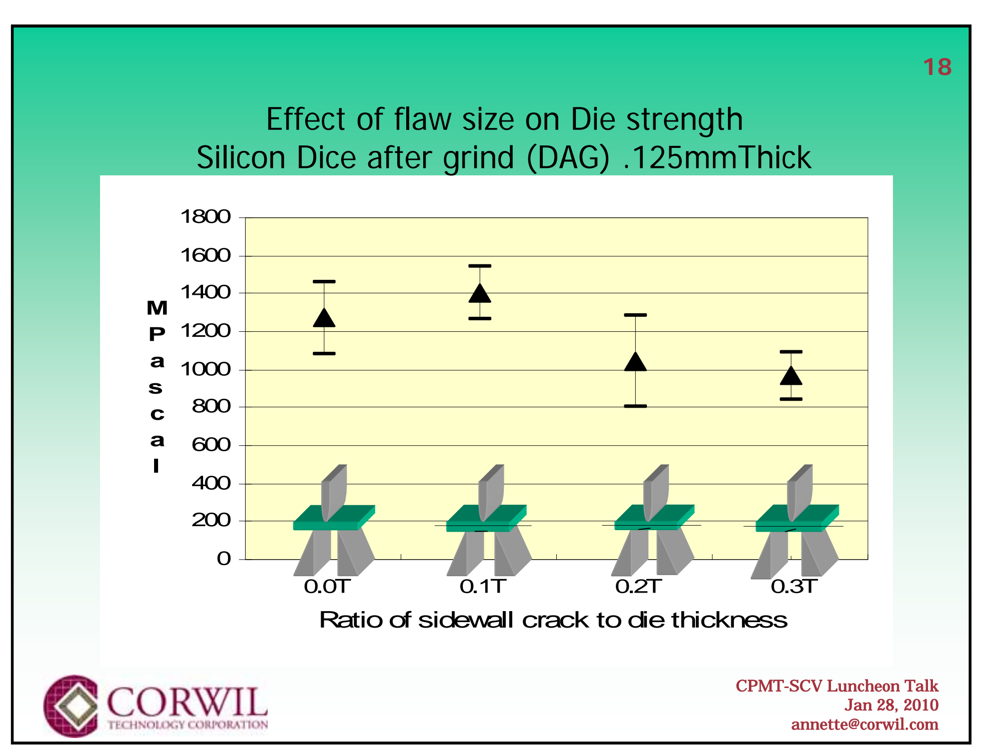
18
Effect of flaw size on Die strength
Silicon Dice after grind (DAG) .125mmThick
MPascal
1800
1600
1400
1200
1000
800
600
400
200
0
0.0T
0.1T
0.2T
0.3T
Ratio of sidewall crack to die thickness
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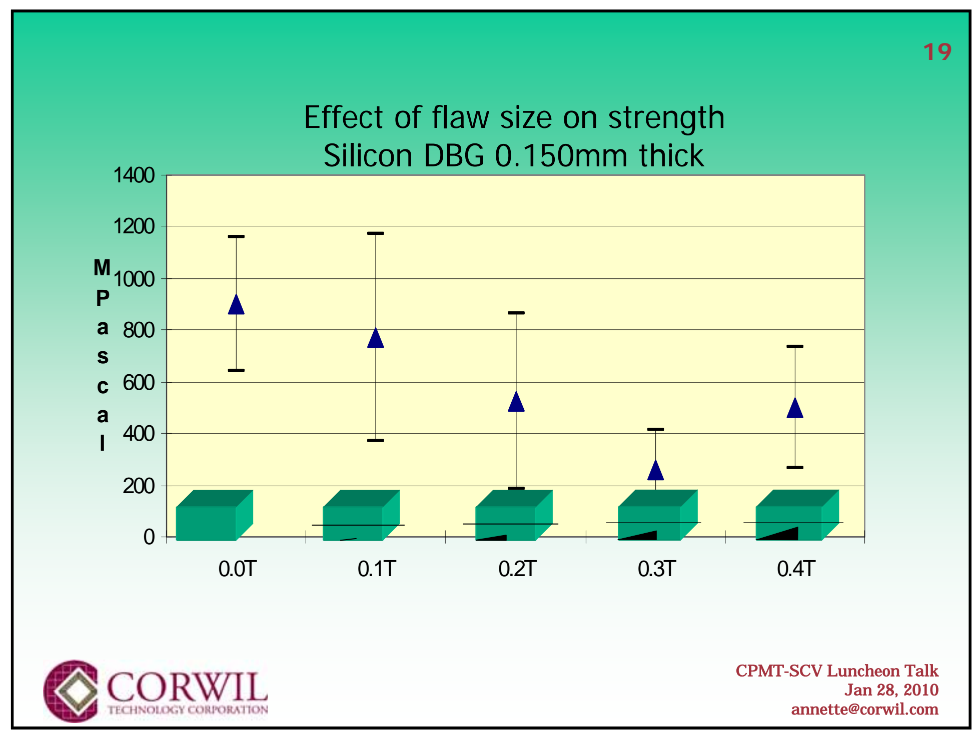
19
Effect of flaw size on strength
Silicon DBG 0.150mm thick
MPascal
1400
1200
1000
800
600
400
200
0
0.0T
0.1T
0.2T
0.3T
0.4T
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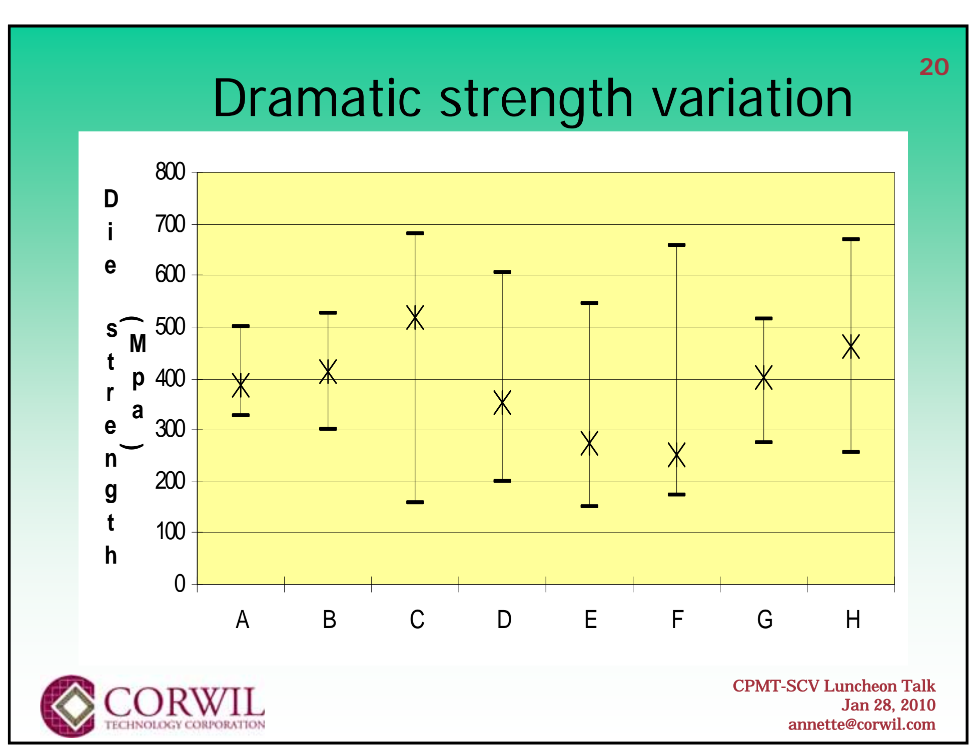
20
Dramatic strength variation
Die strength (Mpa)
800
700
600
500
400
300
200
100
0
A
B
C
D
E
F
G
H
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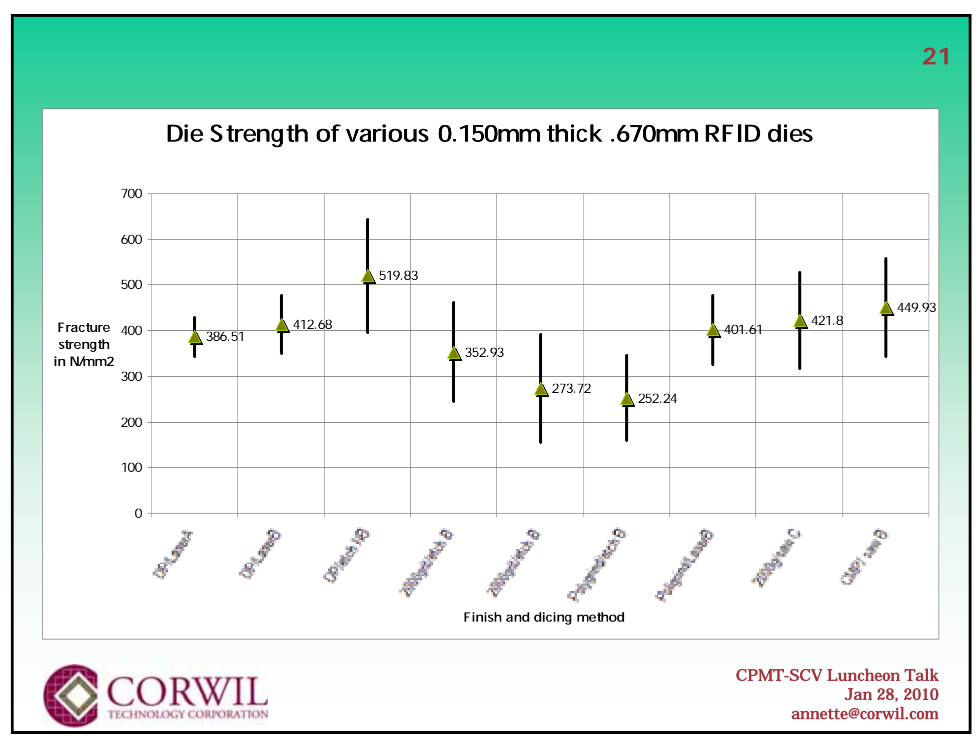
21
Die Strength of various 0.150mm thick .670mm RFID dies
Fracture strength in N/mm2
700
600
500
400
300
200
100
0
386.51
412.68
519.83
352.93
273.72
252.24
401.61
421.8
449.93
Finish and dicing method
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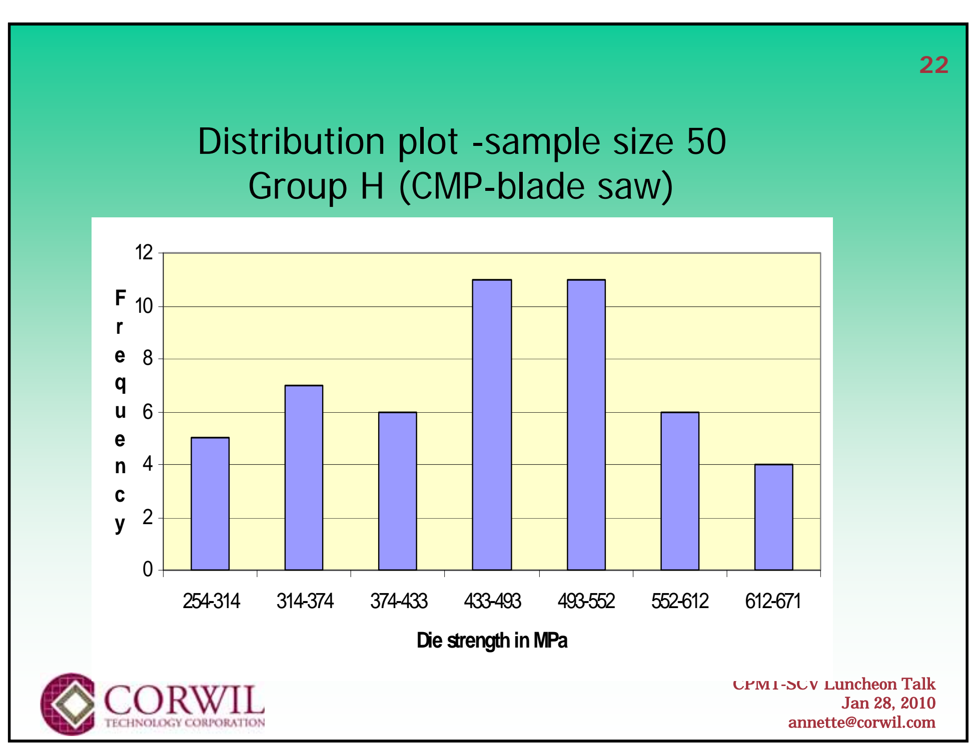
22
Distribution plot -sample size 50
Group H (CMP-blade saw)
Frequency
12
10
8
6
4
2
0
254-314
314-374
374-433
433-493
493-552
552-612
612-671
Die strength in MPa
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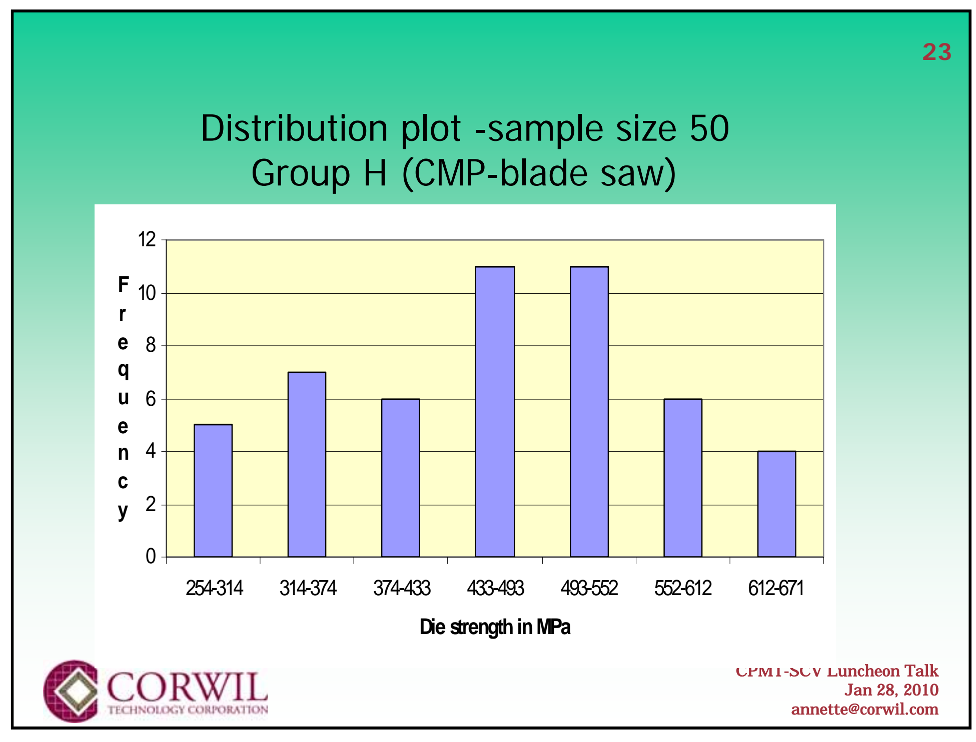
23
Distribution plot -sample size 50
Group H (CMP-blade saw)
Frequency
12
10
8
6
4
2
0
254-314
314-374
374-433
433-493
493-552
552-612
612-671
Die strength in MPa
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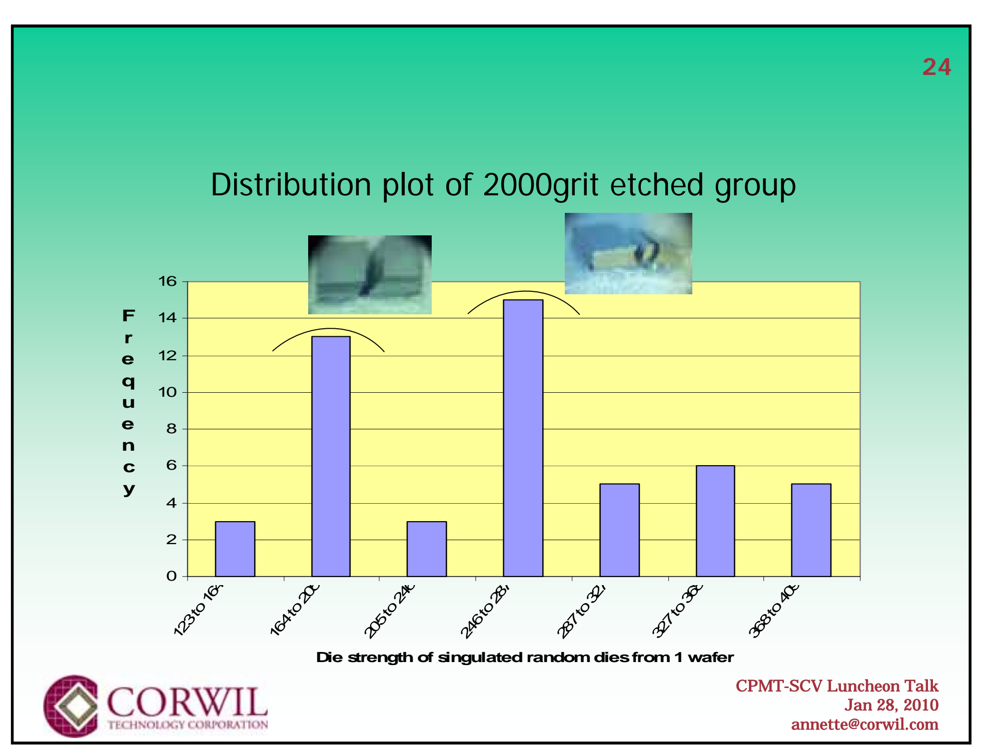
24
Distribution plot of 2000grit etched group
Frequency
16
14
12
10
8
6
4
2
0
Die strength of singulated random dies from 1 wafer
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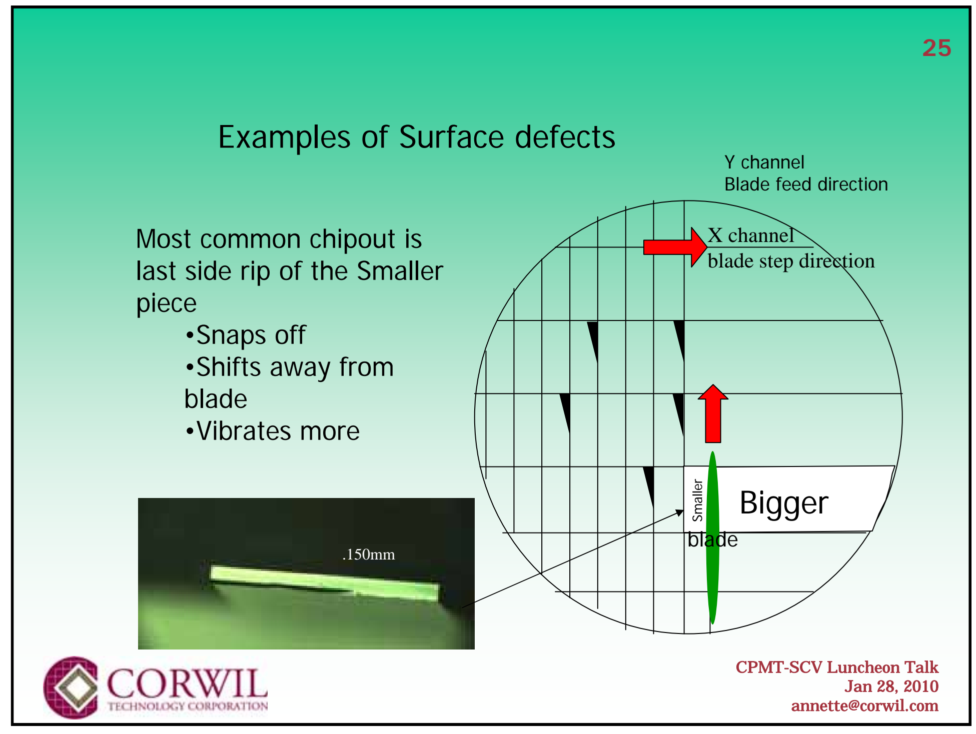
25
Examples of Surface defects
Most common chipout is last side rip of the Smaller piece
•Snaps off
•Shifts away from blade
•Vibrates more
Y channel
Blade feed direction
X channel
blade step direction
Smaller
Bigger
blade
.150mm
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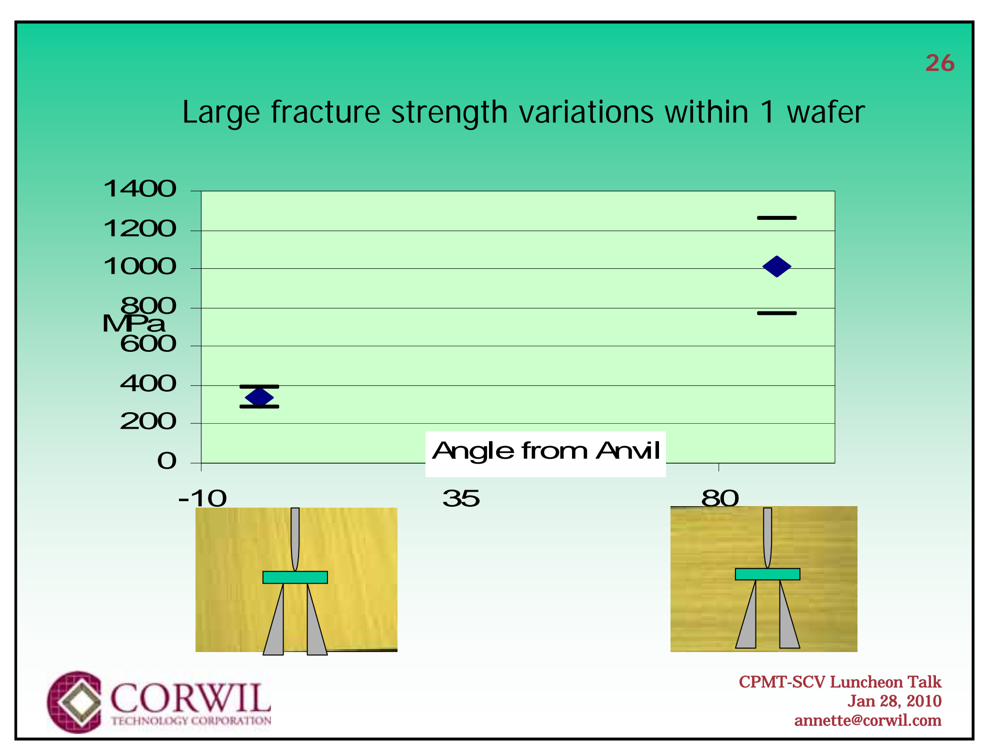
26
Large fracture strength variations within 1 wafer
1400
1200
1000
800
MPa
600
400
200
0
Angle from Anvil
-10
35
80
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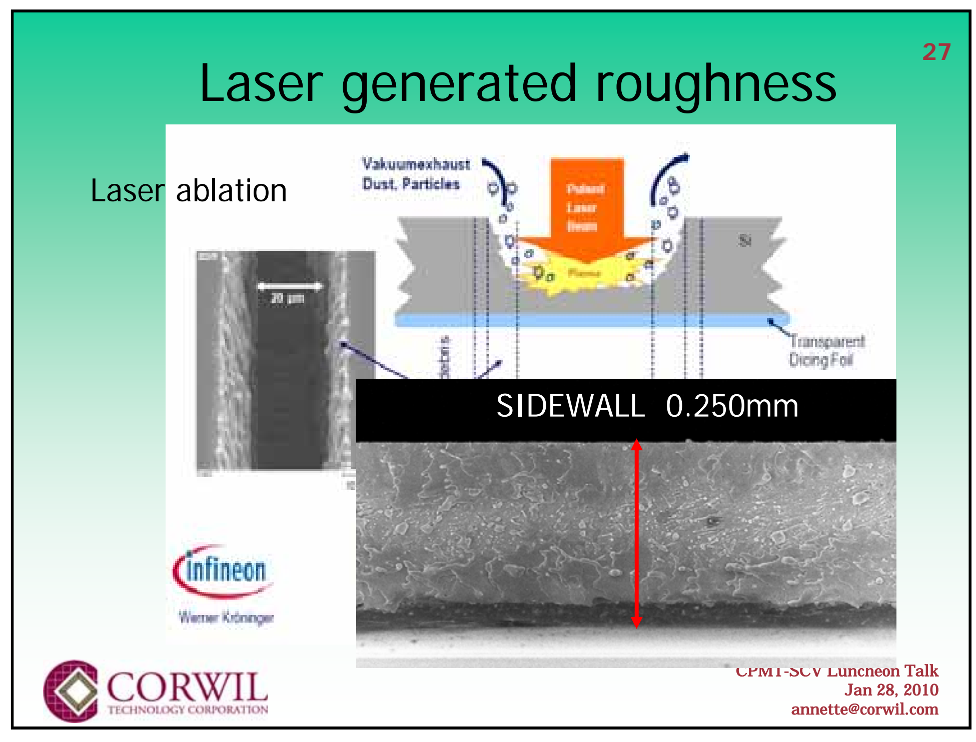
27
Laser generated roughness
Laser ablation
Vakuumexhaust
Dust, Particles
Si
Transparent
Dicing Foil
20 µm
SIDEWALL 0.250mm
infineon
Werner Kröninger
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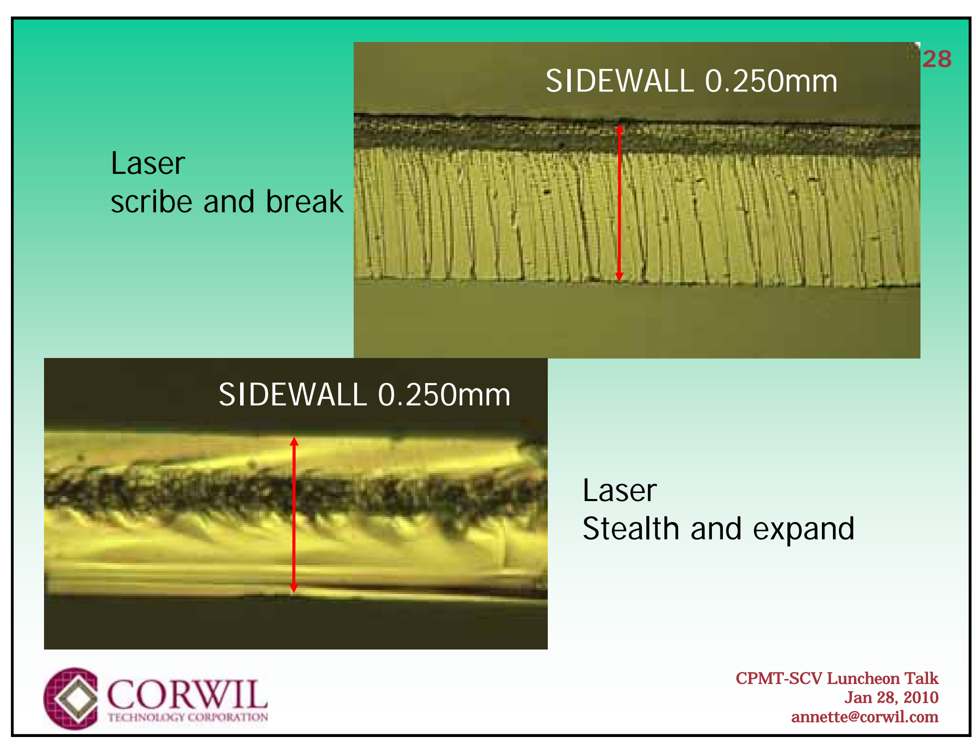
28
Laser
scribe and break
SIDEWALL 0.250mm
SIDEWALL 0.250mm
Laser
Stealth and expand
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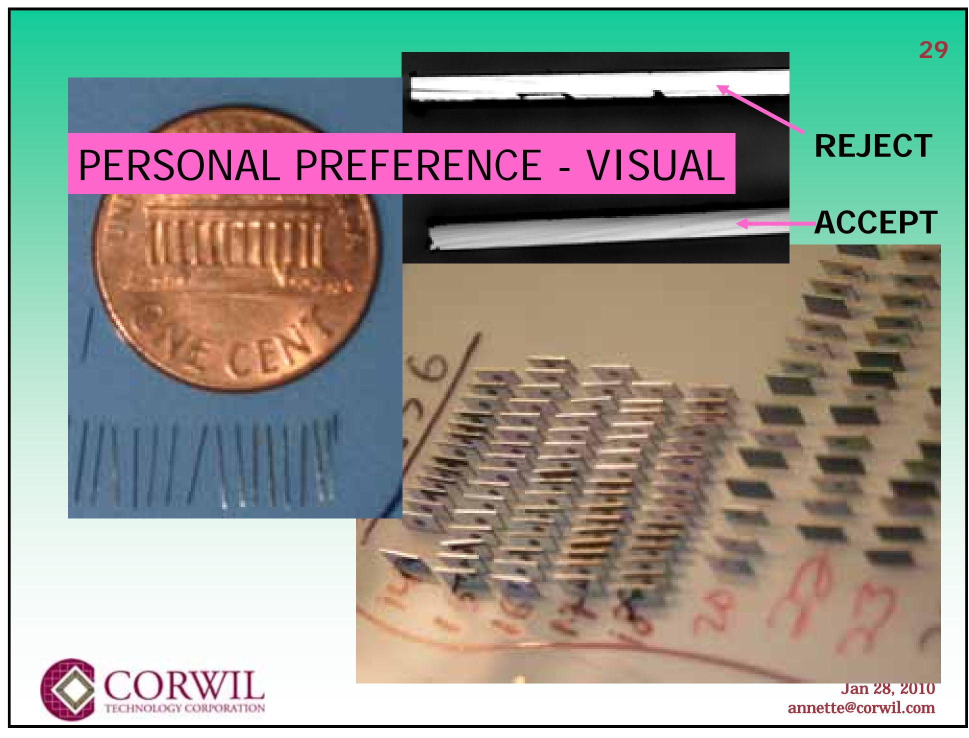
29
PERSONAL PREFERENCE - VISUAL
REJECT
ACCEPT
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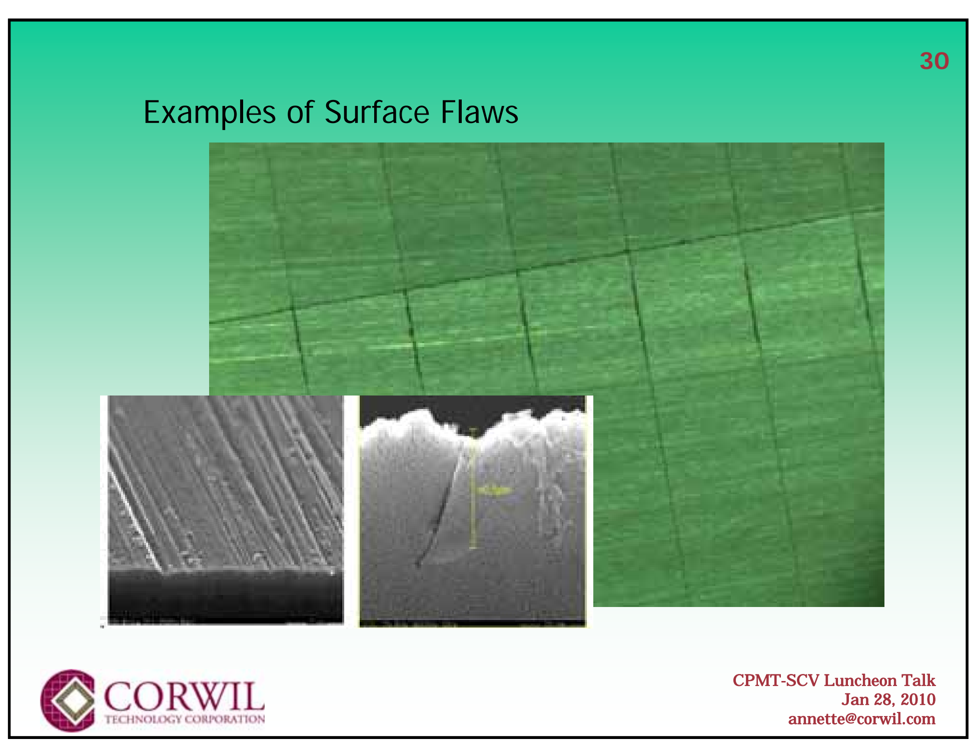
30
Examples of Surface Flaws
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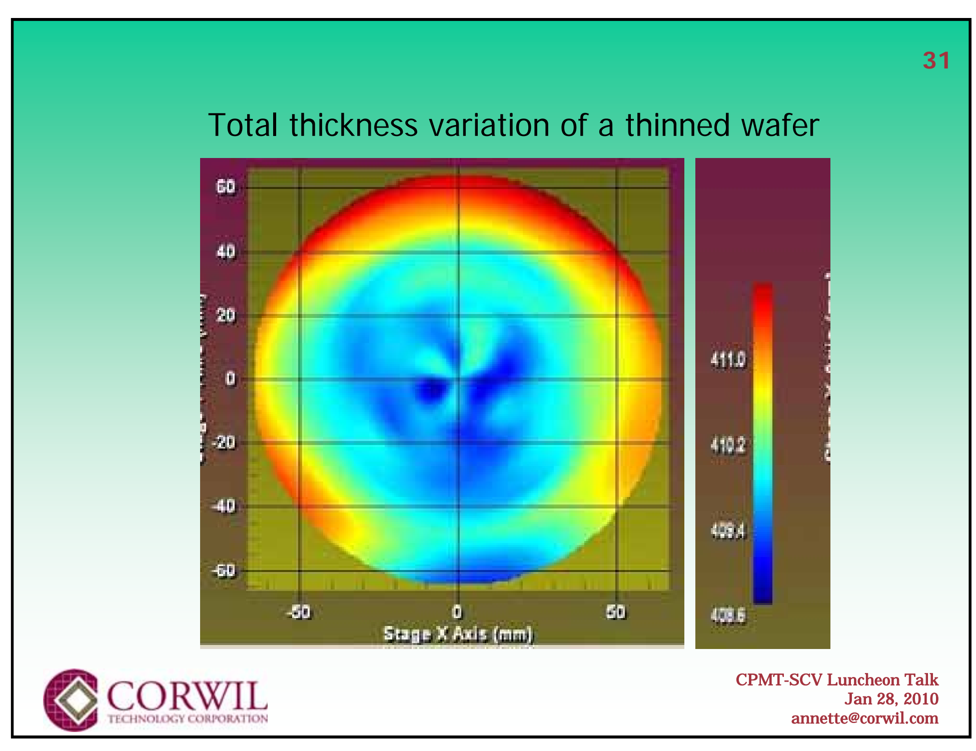

32

TTV HAS MAJOR IMPACT ON ULTRATHIN DIE

Wafer Thinning Target Thickness	8 μm TTV to thickness ratio	TTV effect on 3 pt bend die strength
0.150 mm	5.3% (0.146-0.154mm)	10.6%
0.100 mm	8% (0.096-0.104mm)	16.0%
0.050 mm	16% (0.046-0.054mm)	32.0%

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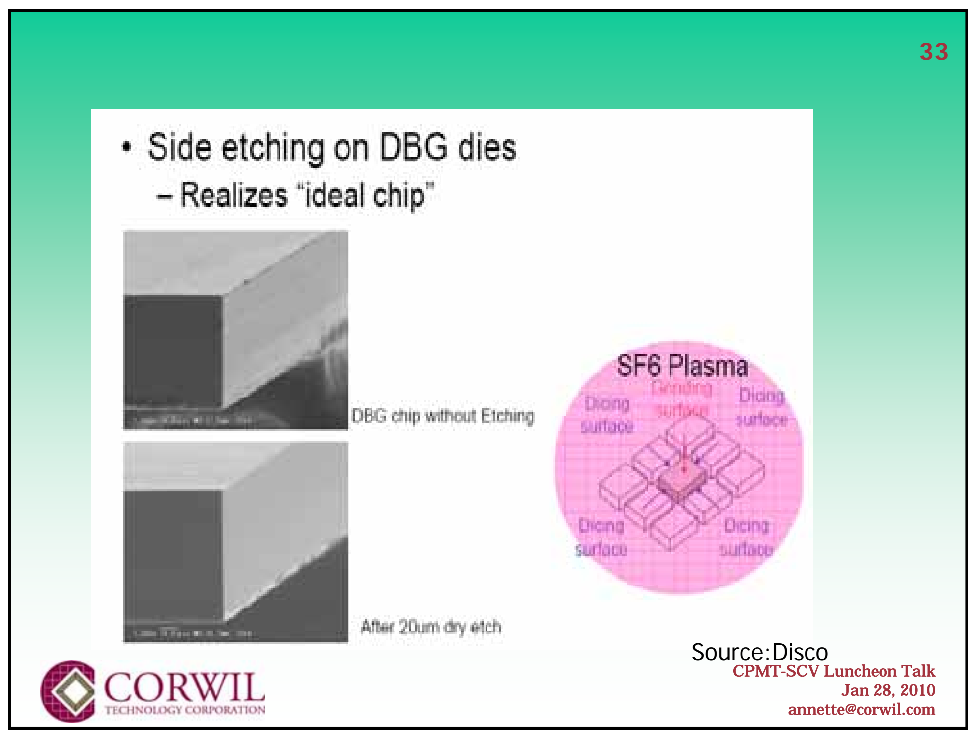
33
Side etching on DBG dies
– Realizes "ideal chip"
DBG chip without Etching
After 20um dry etch
SF6 Plasma
Dicing surface
Grinding surface
Dicing surface
Dicing surface
Dicing surface
Source: Disco
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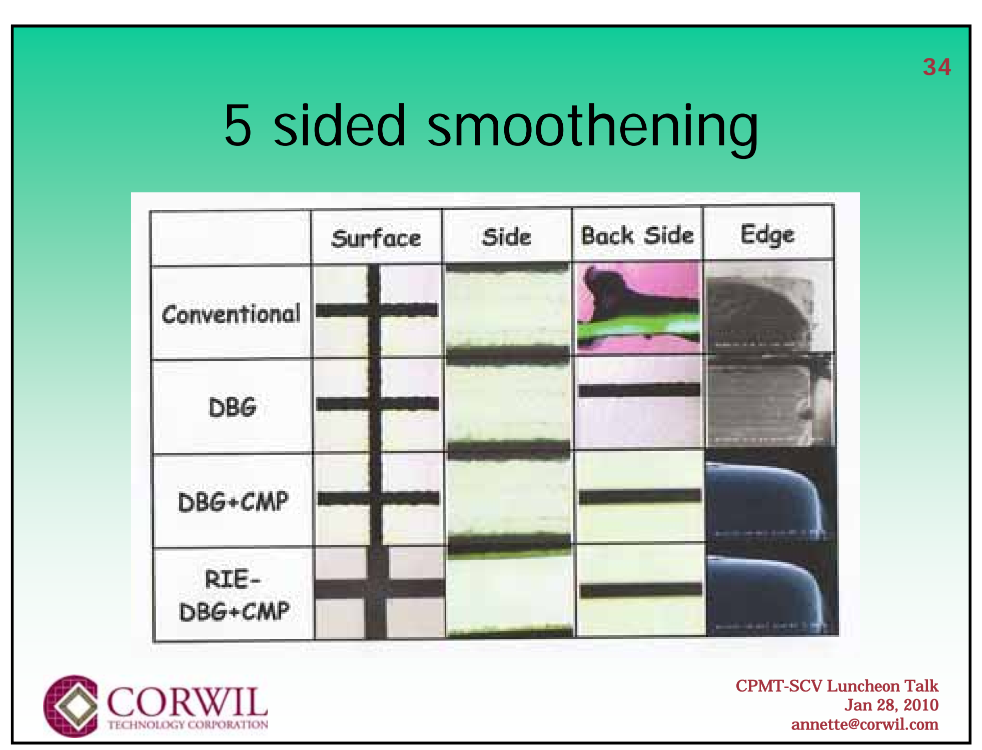
34
5 sided smoothening
Surface
Side
Back Side
Edge
Conventional
DBG
DBG+CMP
RIE-DBG+CMP
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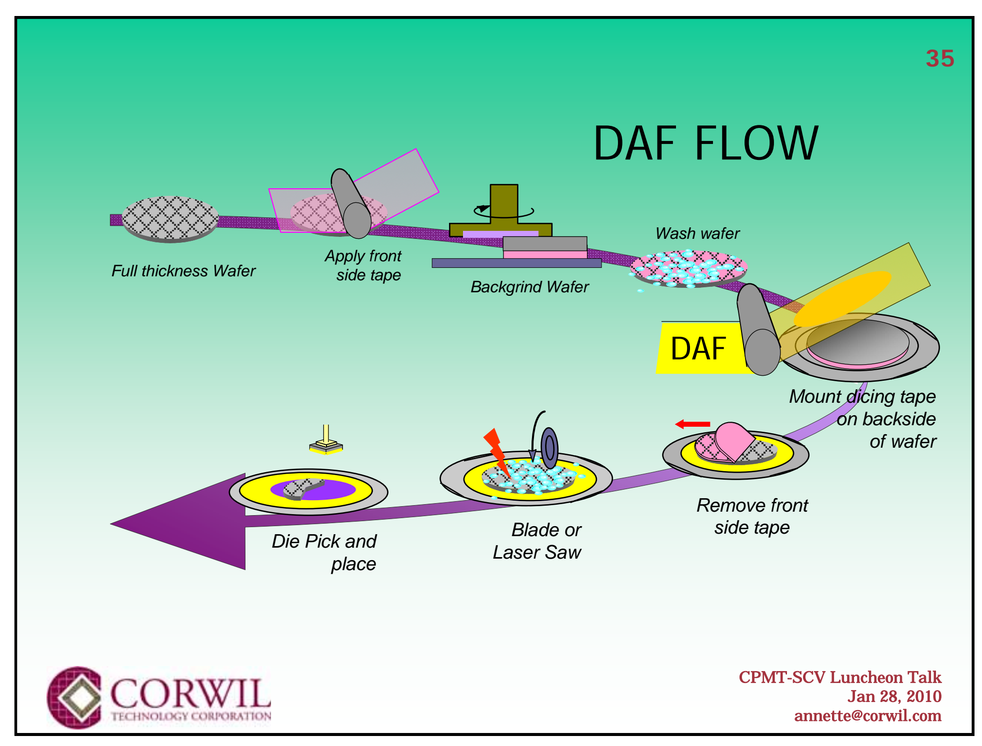
35
DAF FLOW
Full thickness Wafer
Apply front side tape
Backgrind Wafer
Wash wafer
DAF
Mount dicing tape on backside of wafer
Remove front side tape
Blade or Laser Saw
Die Pick and place
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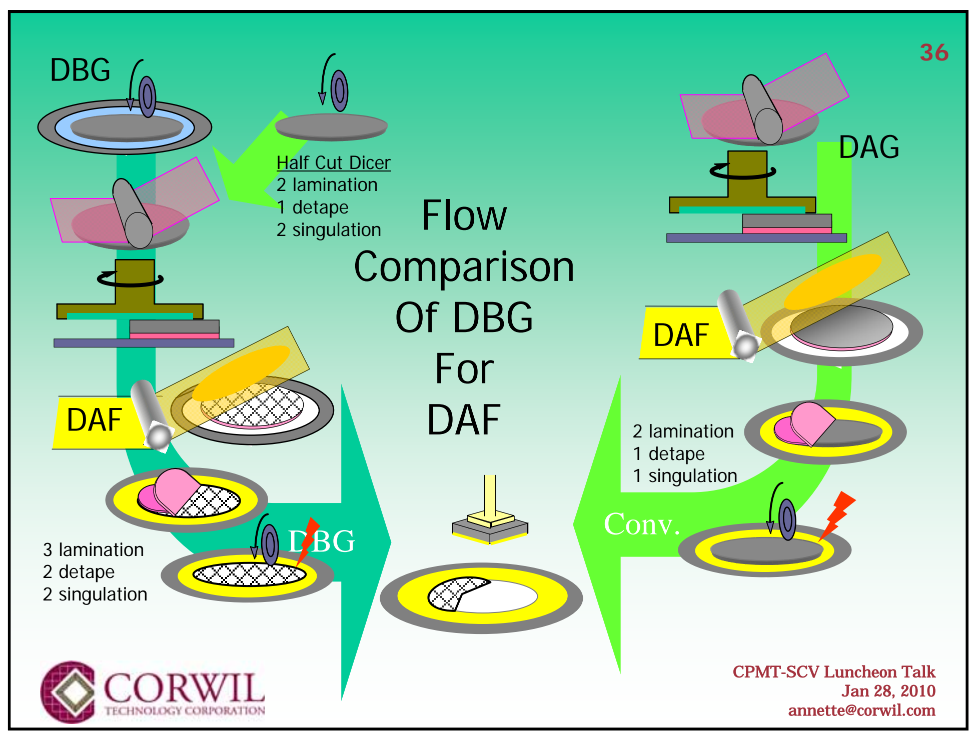
36
DBG
Half Cut Dicer
2 lamination
1 detape
2 singulation
Flow Comparison Of DBG For DAF
DAG
DAF
DAF
2 lamination
1 detape
1 singulation
Conv.
DBG
3 lamination
2 detape
2 singulation
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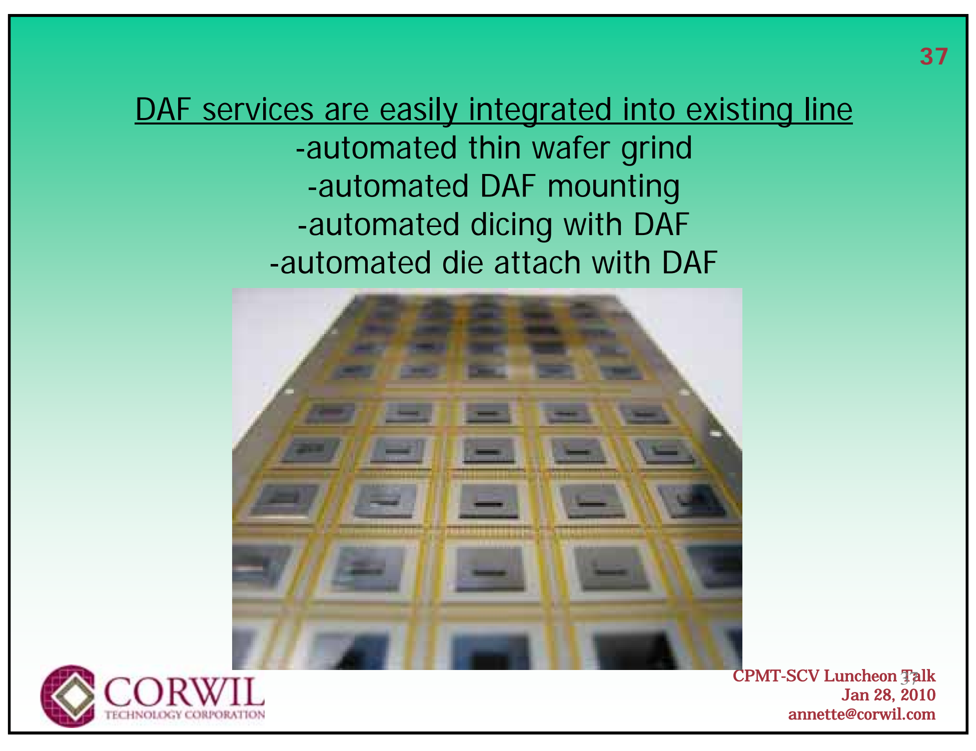
37
DAF services are easily integrated into existing line
-automated thin wafer grind
-automated DAF mounting
-automated dicing with DAF
-automated die attach with DAF
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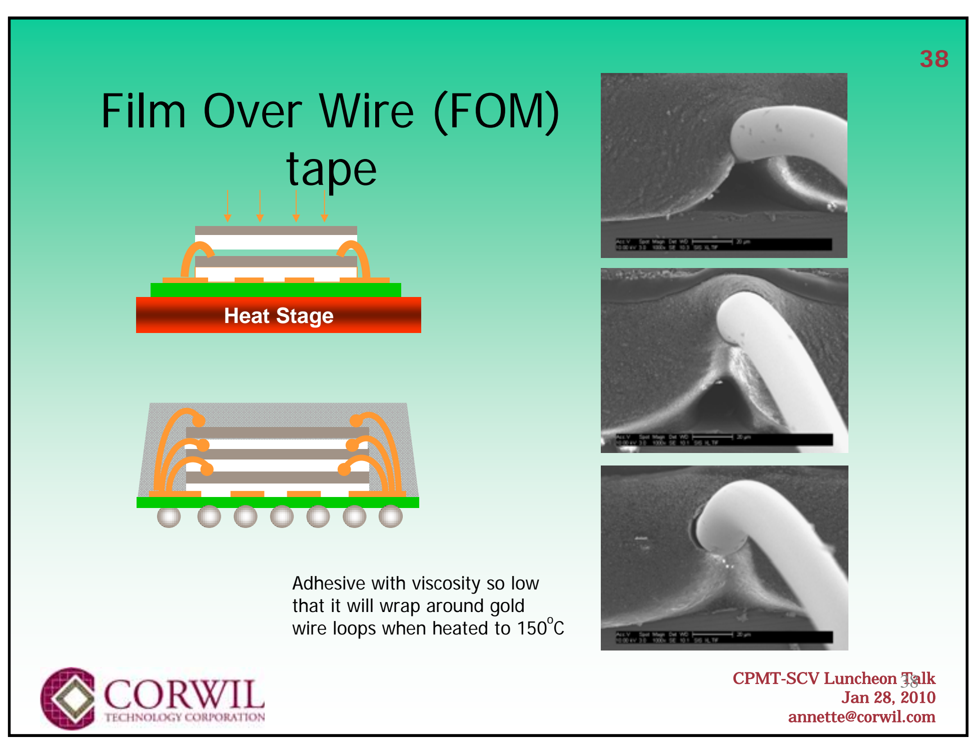
38
Film Over Wire (FOM) tape
Heat Stage
Adhesive with viscosity so low that it will wrap around gold wire loops when heated to 150°C
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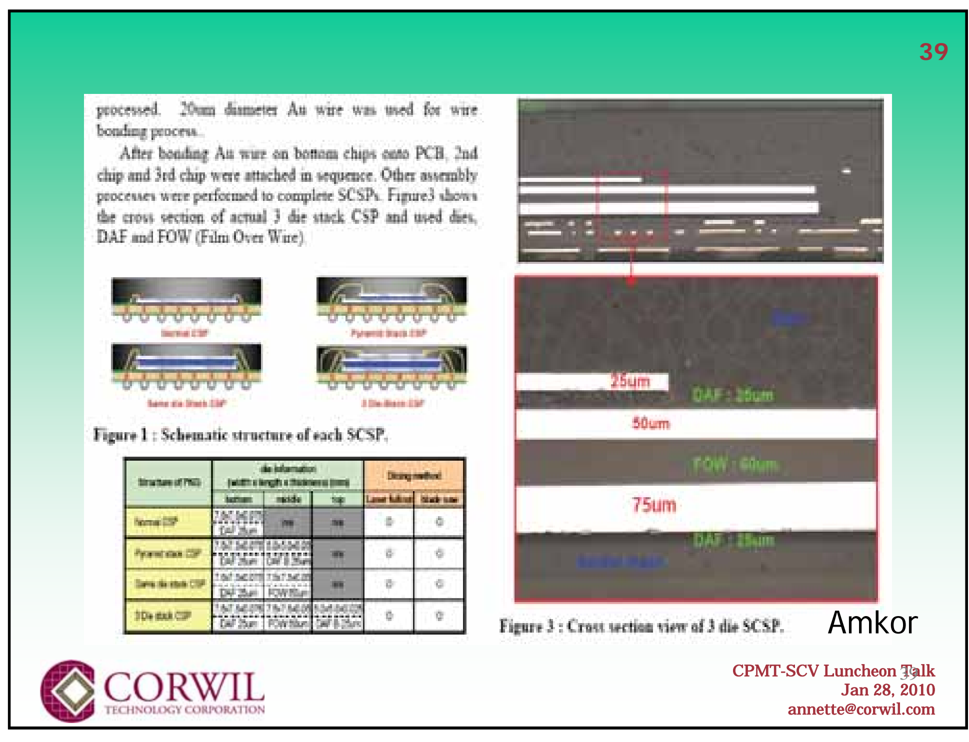


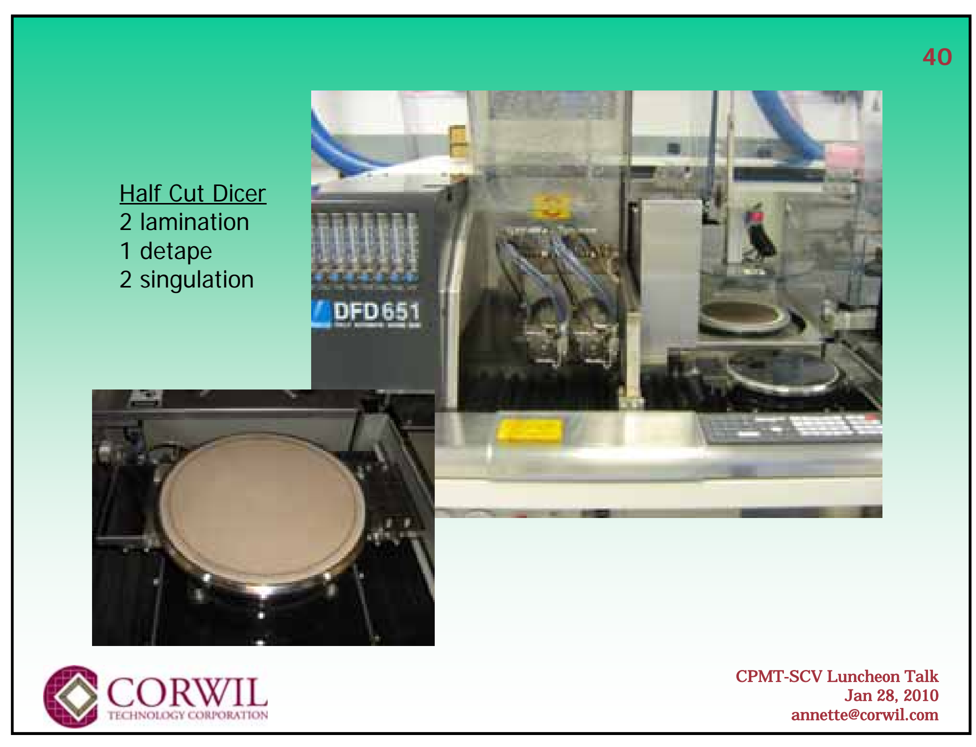
processed. 20um diameter Au wire was used for wire bonding process.

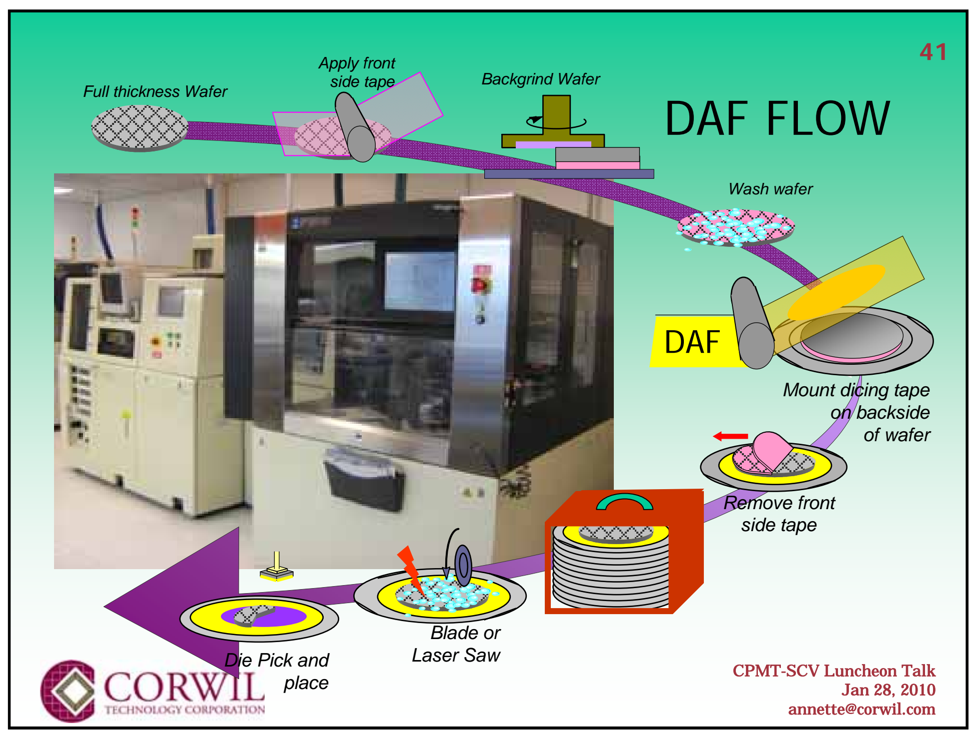
After bonding Au wire on bottom chips onto PCB, 2nd chip and 3rd chip were attached in sequence. Other assembly processes were performed to complete SCSPs. Figure3 shows the cross section of actual 3 die stack CSP and used dies, DAF and FOW (Film Over Wire).

Figure 1 : Schematic structure of each SCSP.

Structure of PKG	die information (width x length x thickness) (mm)			Dicing method	
	bottom	middle	top	Laser fullcut	Blade saw
Normal CSP	[illegible] DAF 25um	n/a	n/a	O	O
Pyramid stack CSP	[illegible] DAF 25um	[illegible] DAF 8.25um	n/a	O	O
Same die stack CSP	[illegible] DAF 25um	[illegible] FOW 60um	n/a	O	O
3 Die stack CSP	[illegible] DAF 25um	[illegible] FOW 60um	[illegible] DAF 8.25um	O	O

Figure 3 : Cross section view of 3 die SCSP.

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DAF FLOW
Full thickness Wafer
Apply front side tape
Backgrind Wafer
Wash wafer
DAF
Mount dicing tape on backside of wafer
Remove front side tape
Blade or Laser Saw
Die Pick and place
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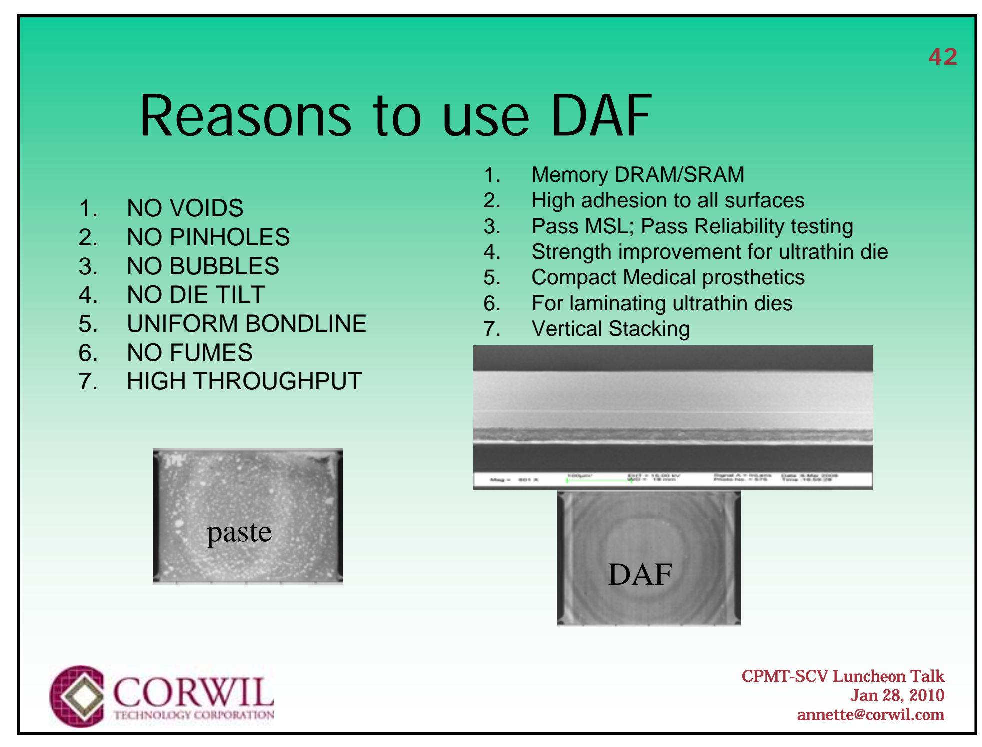
42
Reasons to use DAF
1. NO VOIDS
2. NO PINHOLES
3. NO BUBBLES
4. NO DIE TILT
5. UNIFORM BONDLINE
6. NO FUMES
7. HIGH THROUGHPUT
1. Memory DRAM/SRAM
2. High adhesion to all surfaces
3. Pass MSL; Pass Reliability testing
4. Strength improvement for ultrathin die
5. Compact Medical prosthetics
6. For laminating ultrathin dies
7. Vertical Stacking
paste
DAF
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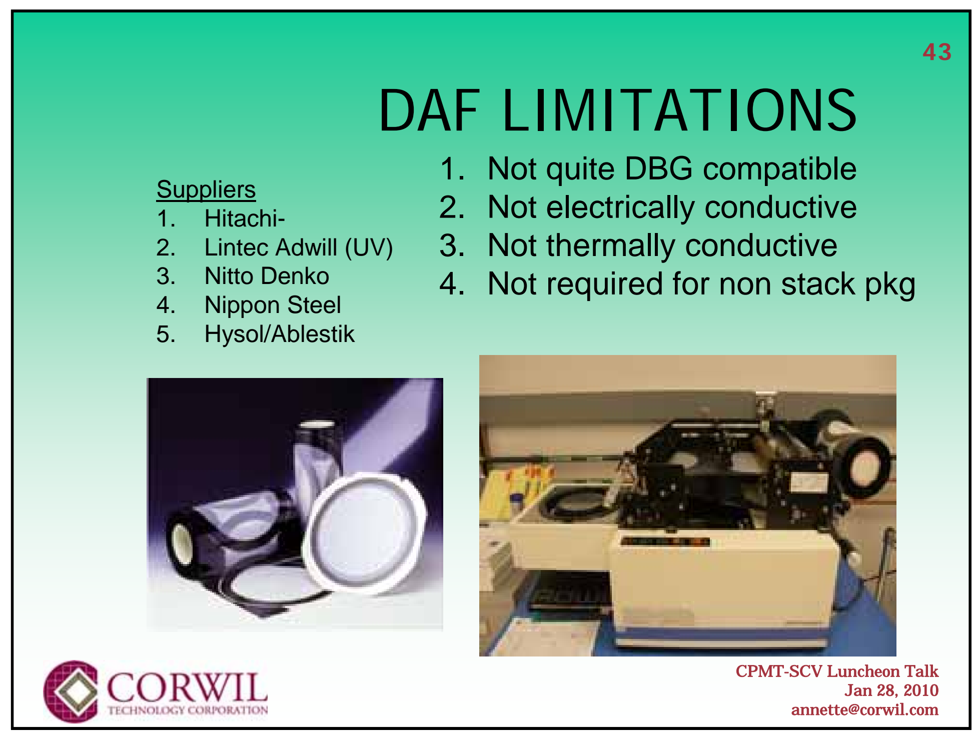
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DAF LIMITATIONS
1. Not quite DBG compatible
2. Not electrically conductive
3. Not thermally conductive
4. Not required for non stack pkg
Suppliers
1. Hitachi-
2. Lintec Adwill (UV)
3. Nitto Denko
4. Nippon Steel
5. Hysol/Ablestik
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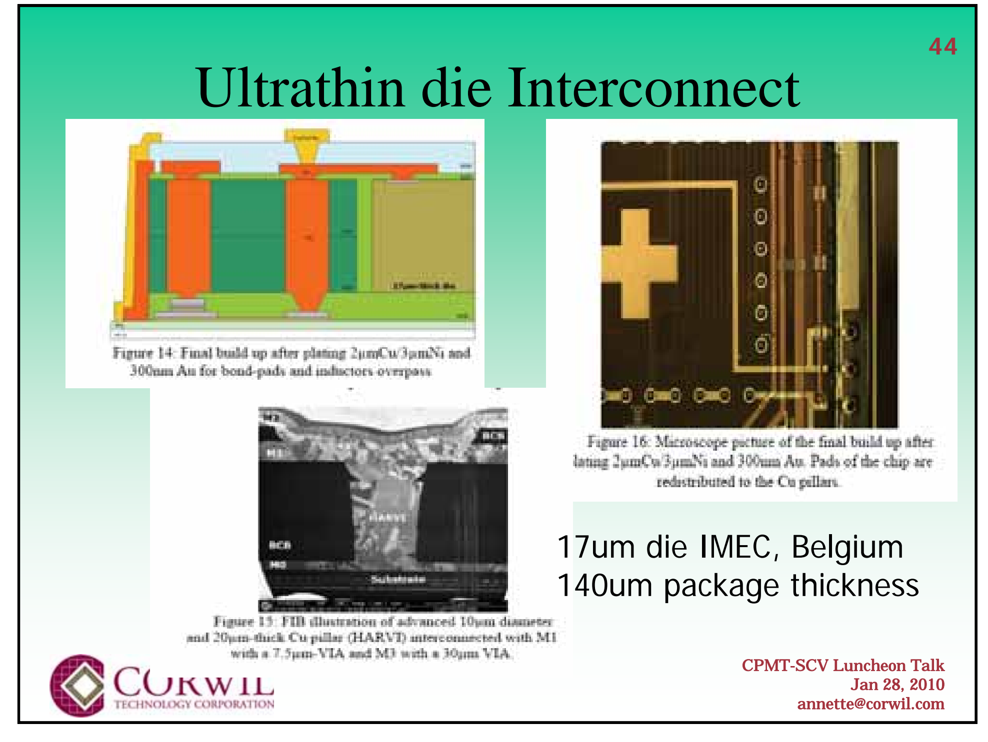
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Ultrathin die Interconnect
Figure 14: Final build up after plating 2µmCu/3µmNi and 300nm Au for bond-pads and inductors overpass
Figure 16: Microscope picture of the final build up after lating 2µmCu/3µmNi and 300nm Au. Pads of the chip are redistributed to the Cu pillars.
Figure 15: FIB illustration of advanced 10µm diameter and 20µm-thick Cu pillar (HARVI) interconnected with M1 with a 7.5µm-VIA and M3 with a 30µm VIA.
17um die IMEC, Belgium
140um package thickness
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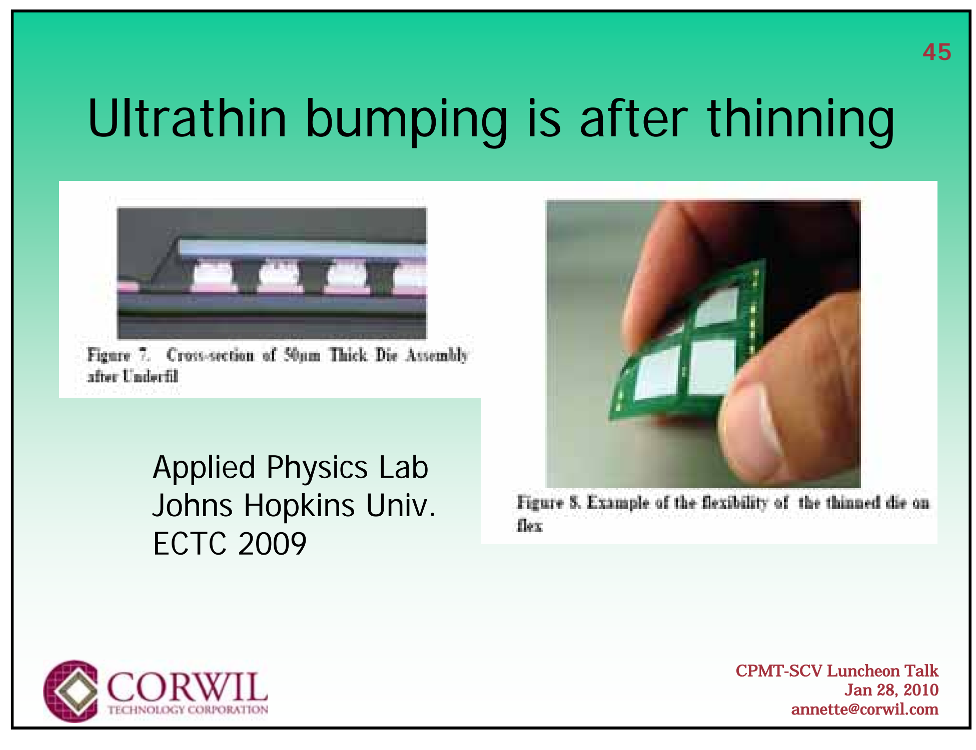

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Summary of Ultrathin Technology

- Dice Before Grind
- Thickness as low as 10um available
- High flexibility
- High scatter of die strength
  - After DAG laser or blade saw
  - After DBG
  - Independent of test methods
  - Predictable by 5 side inspection
- Chemical Smoothening of 5 sides
  - Decreases scatter dramatically
- Die attach using DAF
  - 10um thickness available
- Interconnect
  - Metal patterning
  - Bump (Bump after thinning)

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THANK YOU!!
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Robert Corrao
Dan Miranda
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CORWIL Technology.
Ron Koepp
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