APT ABLEPRINT

Void Free & Cost Saving Solution Provider

The Best Cost Down Solution for Flip Chip

part2 @2015

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Void Free Solution Provider

Flip Chip Underfill Alternative

CUF vs. MUF vs. NCP

Who takes Pie?

The one who offers lower cost

- APT's innovated solution makes the process cost of **CUF** lower than MUF and pre-applied UF through assistance of Void Termination System w/ support of simplified process, broadened process window and boost dispenser throughput

APT Product & Process Roadmap

2016 Target
Cost : CUF < MUF

Solution 4:

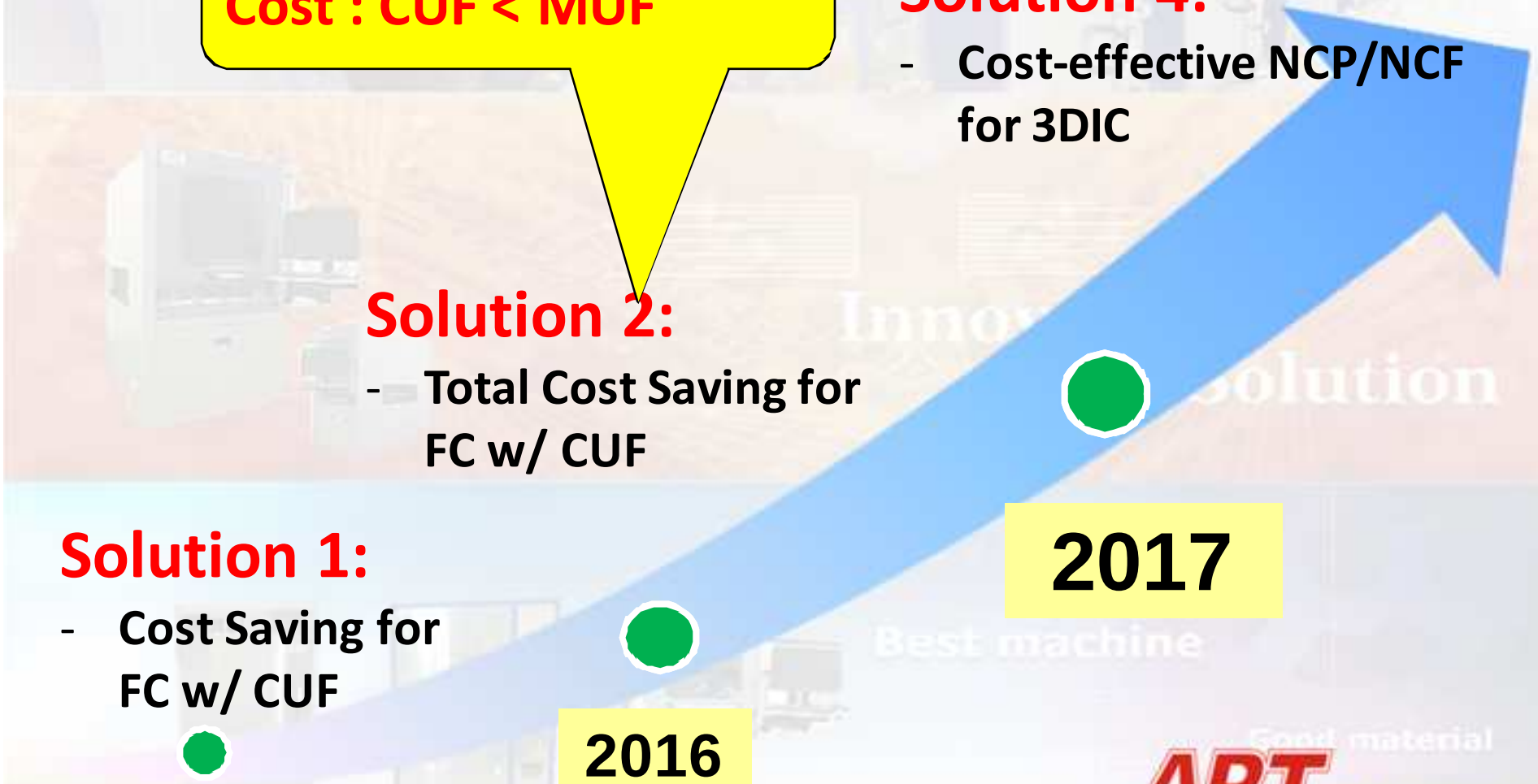
- Cost-effective NCP/NCF for 3DIC

Solution 2:

- Total Cost Saving for FC w/ CUF

Solution 1:

- Cost Saving for FC w/ CUF



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Agenda

- 2014 Cost Saving for FC w/ CUF
- 2016 Total Cost Saving for FC w/ CUF

Operation Cost Estimation

part1.2014 : CUF Solution

Dispenser (CUF)

Dispenser + TM(CUF + MD)

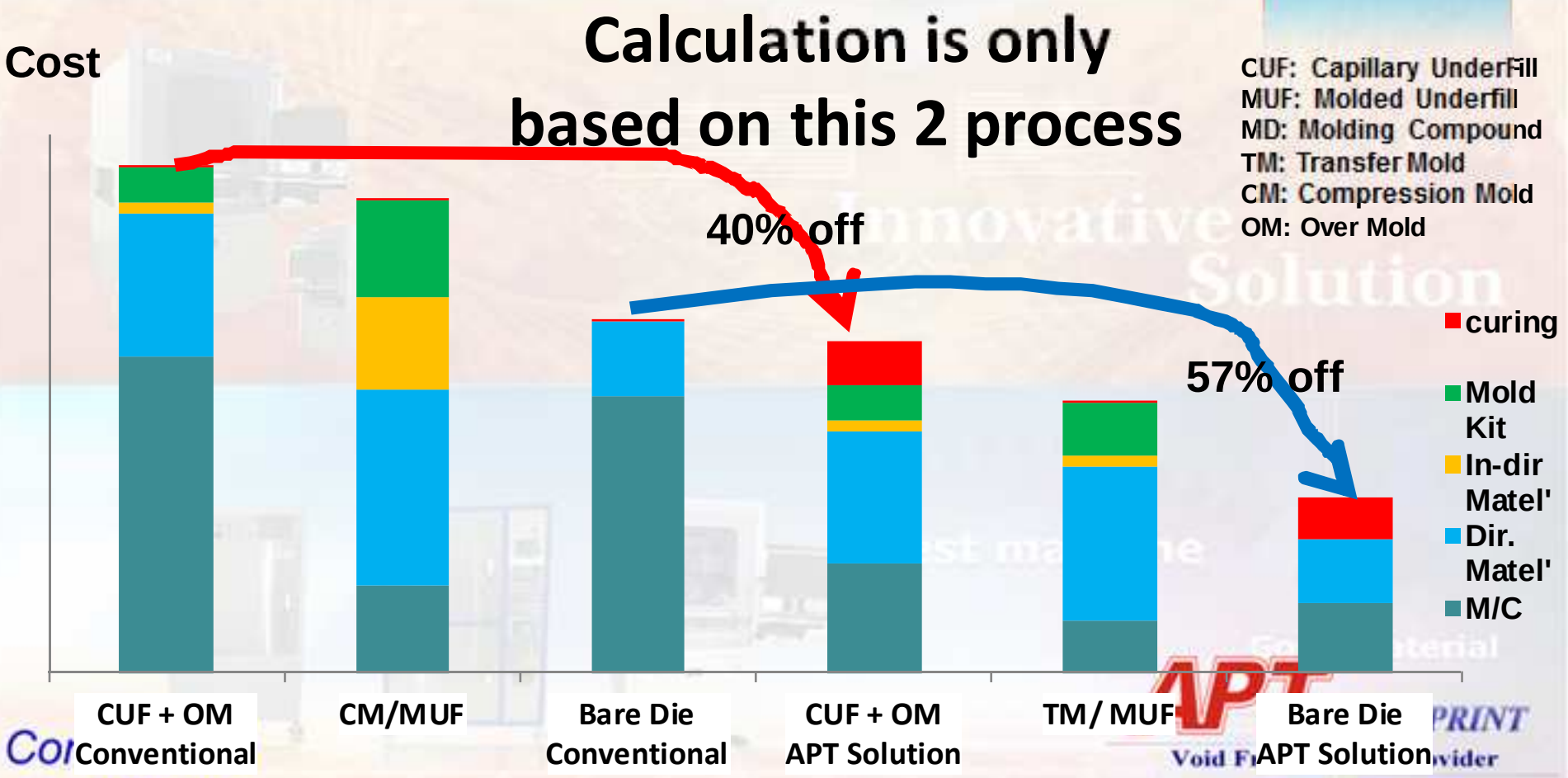
TM(MUF)

&

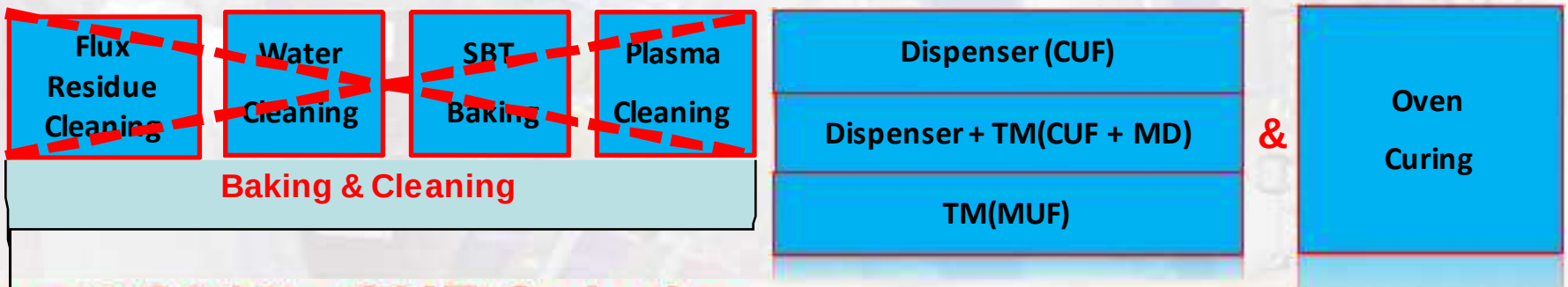
Oven Curing

Calculation is only based on this 2 process

CUF: Capillary UnderFill
MUF: Molded Underfill
MD: Molding Compound
TM: Transfer Mold
CM: Compression Mold
OM: Over Mold



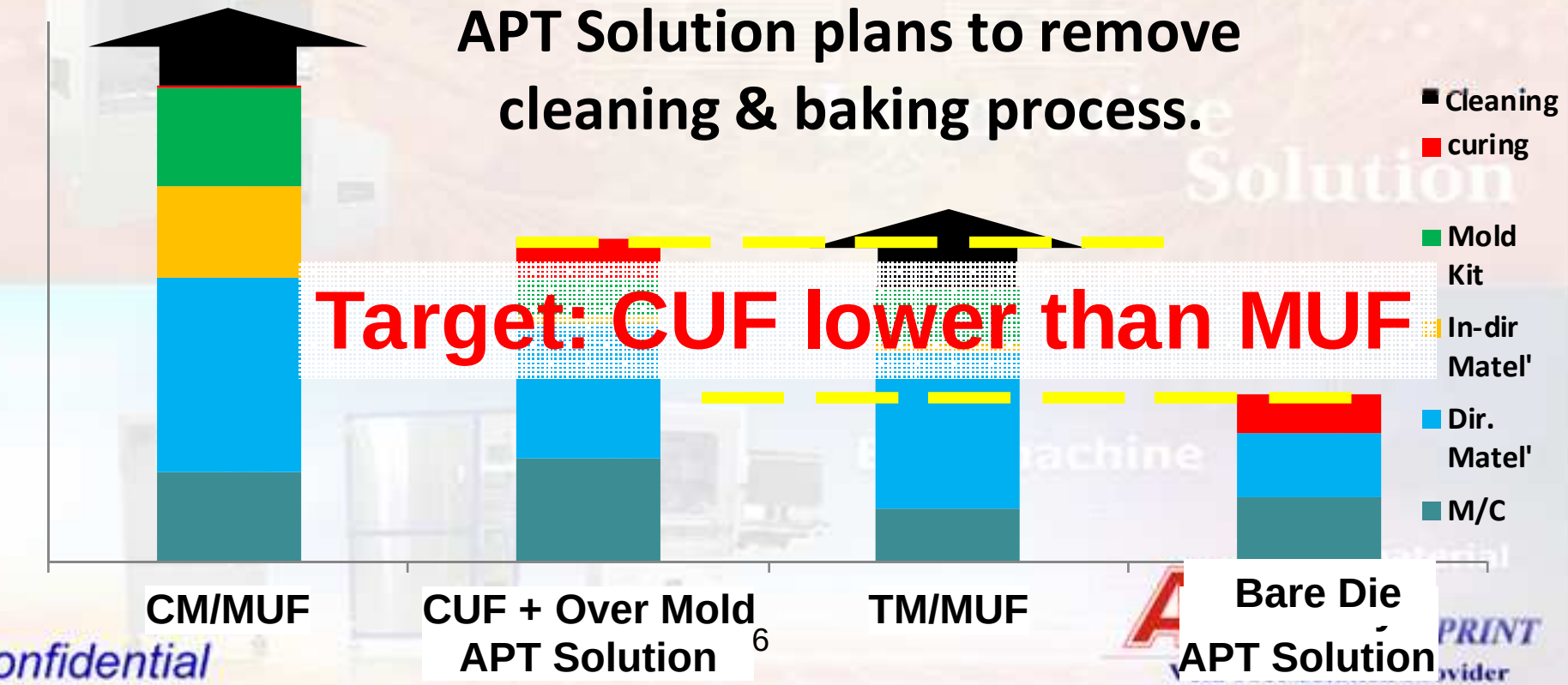
Operation Cost Estimation

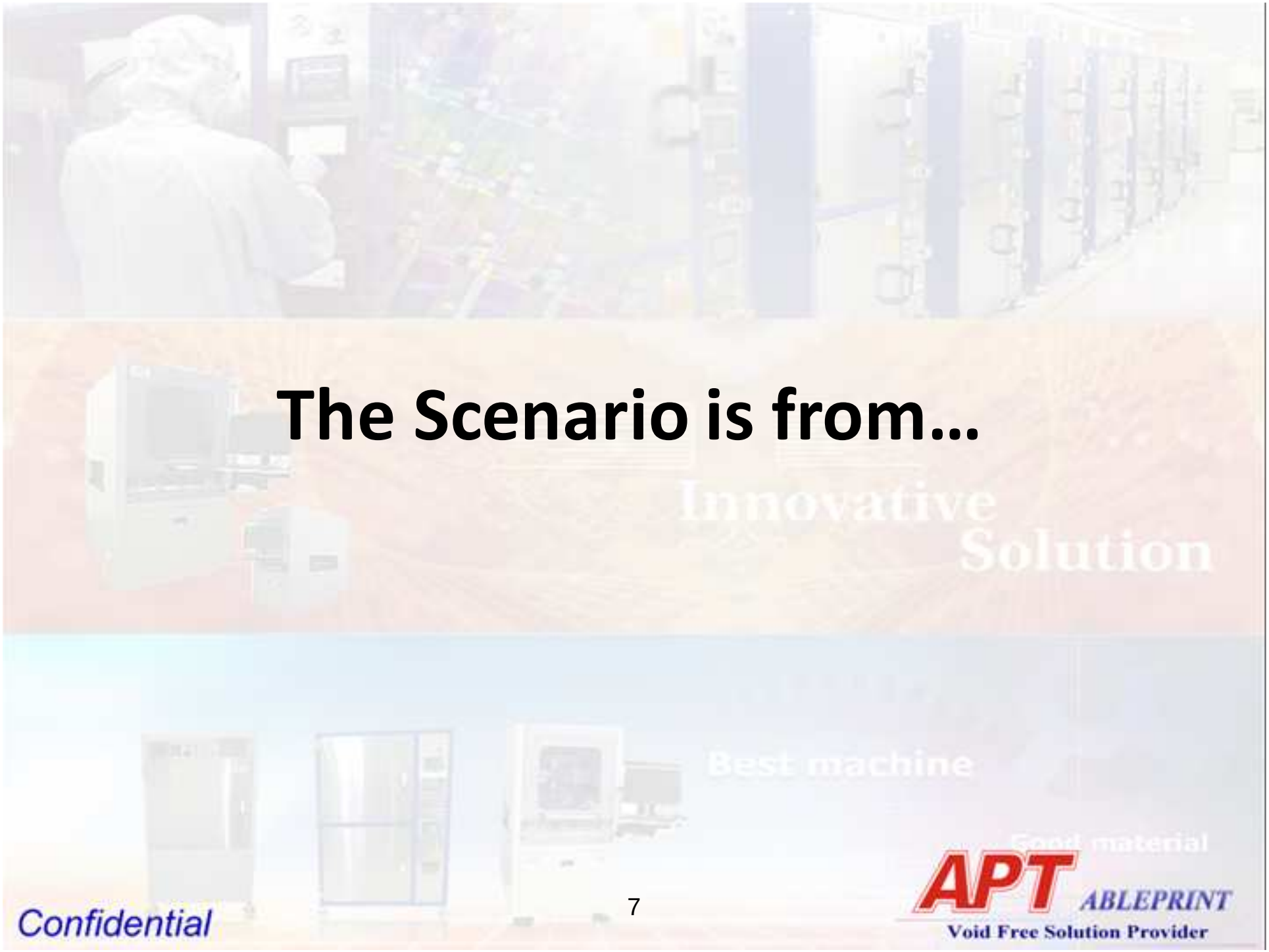


part2.2016 : CUF Solution

TM: Transfer Mold
CM: Compression Mold

APT Solution plans to remove cleaning & baking process.





The Scenario is from…

APT Solution @2014

VTS

Void Terminator System

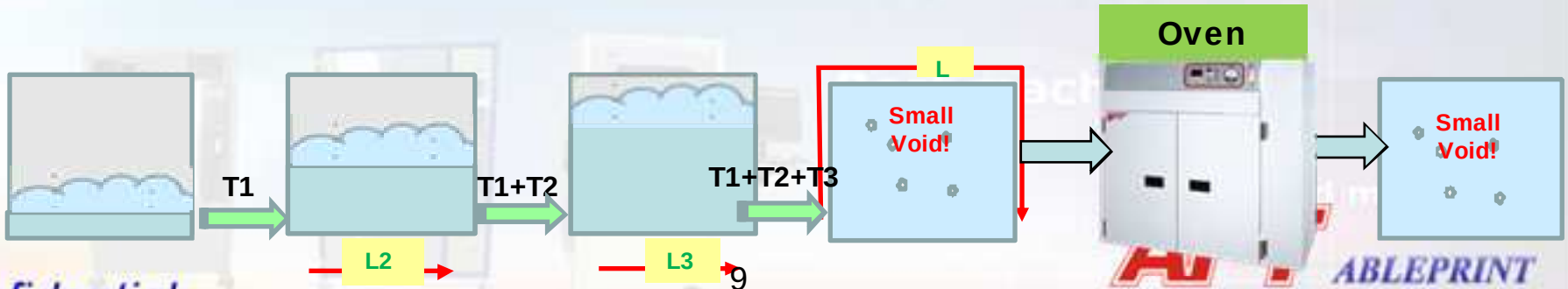
APT Solution

Tactic: we create Void and then Terminate it.

- APT advanced dispensing pattern : U or 口

VS.

- Conventional dispensing methodology :

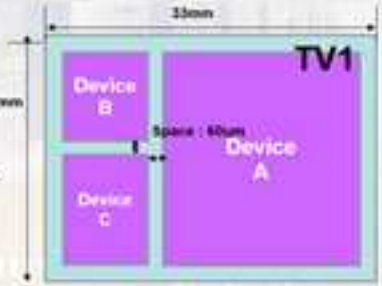


Feature of VTS – Cost Saving

Case 1

Project : TCCUF(Chip on Si-interposer)

- ✓ Chip :
  - Chip : Cu pillar bump
  - Chip size :
    - Device A : 22x22mm^2
    - Device B : 8.5x9mm^2
    - Device C : 13.0x9mm^2
  - Chip T. : 100um
  - Gap : 35um
  - Bump pitch : 150um
- ✓ Underfill :
  - Hitachi, Namics
- ✓ Dispenser :
  - APT-BUP-001A
  - Jet nozzle size: 75um
  - □ pattern for all device
- ✓ Pressure Oven :
  - APT VTS



Experiment arrangement and result

✓The dispensing pattern is fixed as U+□ and dispensing time is enhance from

540sec/pkg to 45sec/pkg.

UPH x10

Case 2

Product : TCCUF

- ✓ Chip
  - Chip size: ~9x10mm^2
  - Chip thickness: 100um
  - Gap chip&sbt 20~30um
  - Bump pitch: C2 40/80um
- ✓ Underfill :
  - Namics
  - 5.4mg
- ✓ Pressure Oven :
  - APT VTS Oven
- ✓ Dispenser :
  - APT-BUP
  - Jet nozzle size: 75um
  - U + I pattern, 1 pass

I Pattern: 30 sec/pkg

U + I Pattern: 10 sec/pkg.

UPH x3

Experiment arrangement

✓The dispensing pattern is fixed as U+I in order to make serious void entrapped under the chip.

✓VTS predicts to eliminate big void which is caused by U & I patterning.

Case 3

- ✓ Chip
  - Chip size: 10x12mm^2
  - Chip type : Cu pillar bump
  - Chip thickness: 600um
  - Gap chip&sbt 35um
  - Bump pitch: 60um
- ✓Underfill :
  - Namics U8410-219
  - 25mg : 12.5+12.5mg
  - 20MG : 10+10mg
- ✓Dispenser :
  - Asyntek
  - Jet nozzle size: 100um
  - U pattern, 2 pass
  - MCL pattern, 2 pass
- ✓Pressure Oven :
  - APT VTS Oven

TV3

✓U pattern

UPH x9.5

✓MCL pattern

Case 4

TV4

Condition	Before Cure	After Cure	Remark
With Normal oven			Still has small void

UPH x7.5

APT VTS (Skip plasma & pre-baking)

No void

UPH

(190sec → 25sec)

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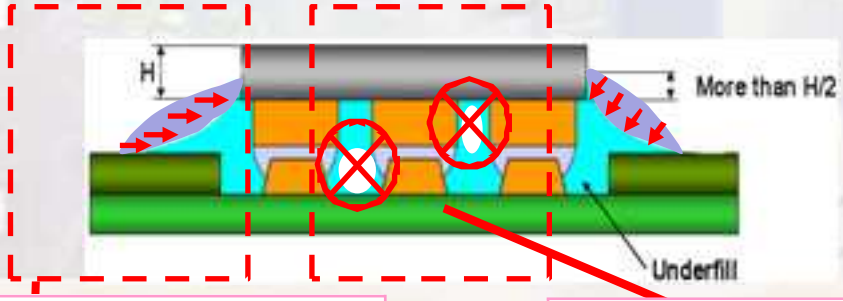
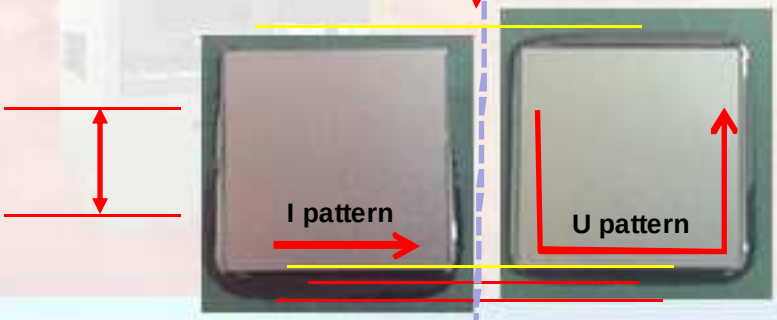
Feature of VTS – Quality Improvement



Bleeding, Creeping control

I Pass **U Pass**



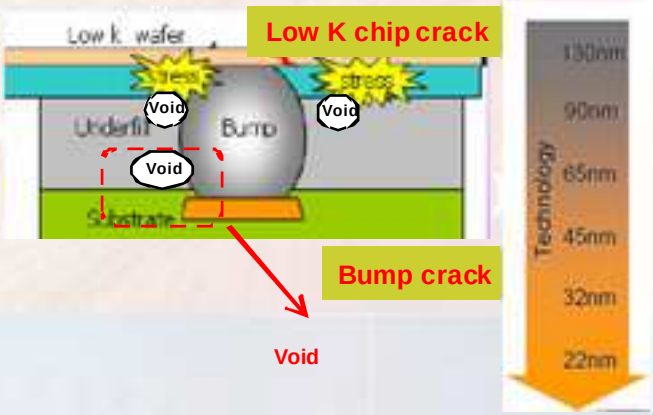
To control bleeding, creeping is getting critical in SiP package and thin chip FCCSP respectively.

APT Solution is designed for it.

CUF material is capable to be saved 10%~25%.

APT Solution is designed for it.

Stress concern



Low K wafer for better signal integrity is more brittle and bump becomes fragile in advanced Si nodes. Considering minimizing stress impact, void size, procedure of de-void must be well controlled as slighter as possible.

APT Solution is designed for it.

TV – Cost Comparison(CUF vs MUF)

Process : TCCUF/FCCUF

Chip information

Chip size: 9x10mm^2
Chip thickness: 100um
Bump: Cu pillar

Dispenser information

Dispenser UPH
Conventional Ix6 : 180ea
Aggressive U+□: 498ea

Mat'l information

VFS: CUF 5.40mg/unit
VTS: CUF 4.34mg/unit
MUF: 25g/strip
SBT : 56units/strip

Dispenser Price
Conventional : 200k USD
Cost-effective : 130K USD

U+□

CUF : 1.3 USD/g
CM MUF : 40 USD/Kg ; 2 strips/120sec
TM MUF : 32 USD/Kg ; 2 strips/120sec
TM MC : 14.5 USD/Kg ; 2 strips/90sec

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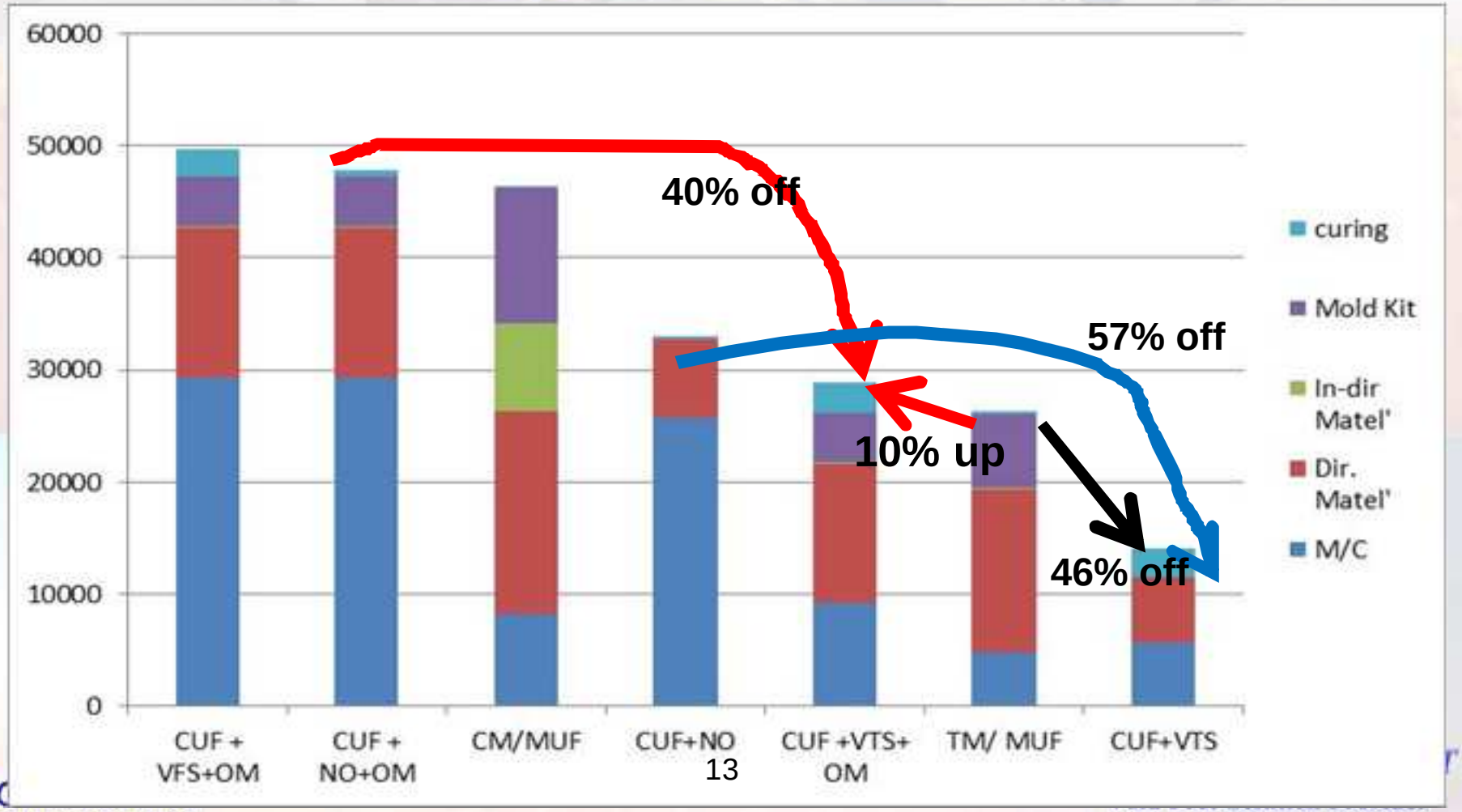
Operation Cost Estimation

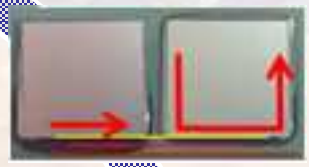
Conclude: the cost of CUF Underfill & Oven Curing with VTS,
- w/ Over Mold-cost saving 40%; w/o Over Mold-cost saving 57%。
- Compare to TM MUF, w/ Over Mold cost up 10%；w/o Over Mold-cost saving 40%



Innovated Alternative

VTS: Void Terminator System

Prebake removed



Underfill efficiency up 10-25%

VTS

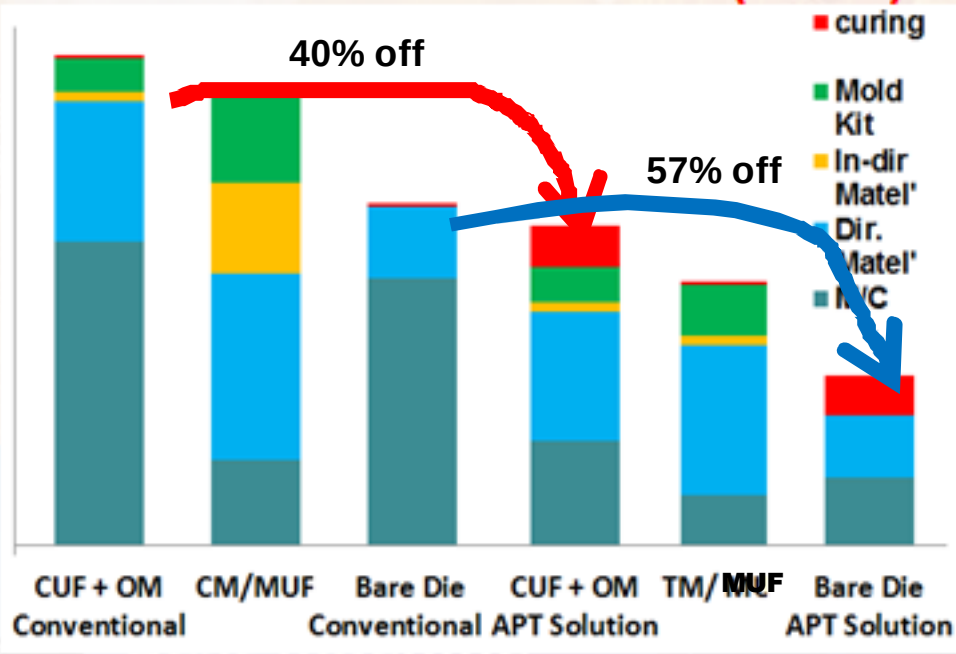
Throughput up 30%-1000%

Extend Q Time

From 2 hours to 8 hours

Devoid & Cure

Operation Cost Comparison (2014)



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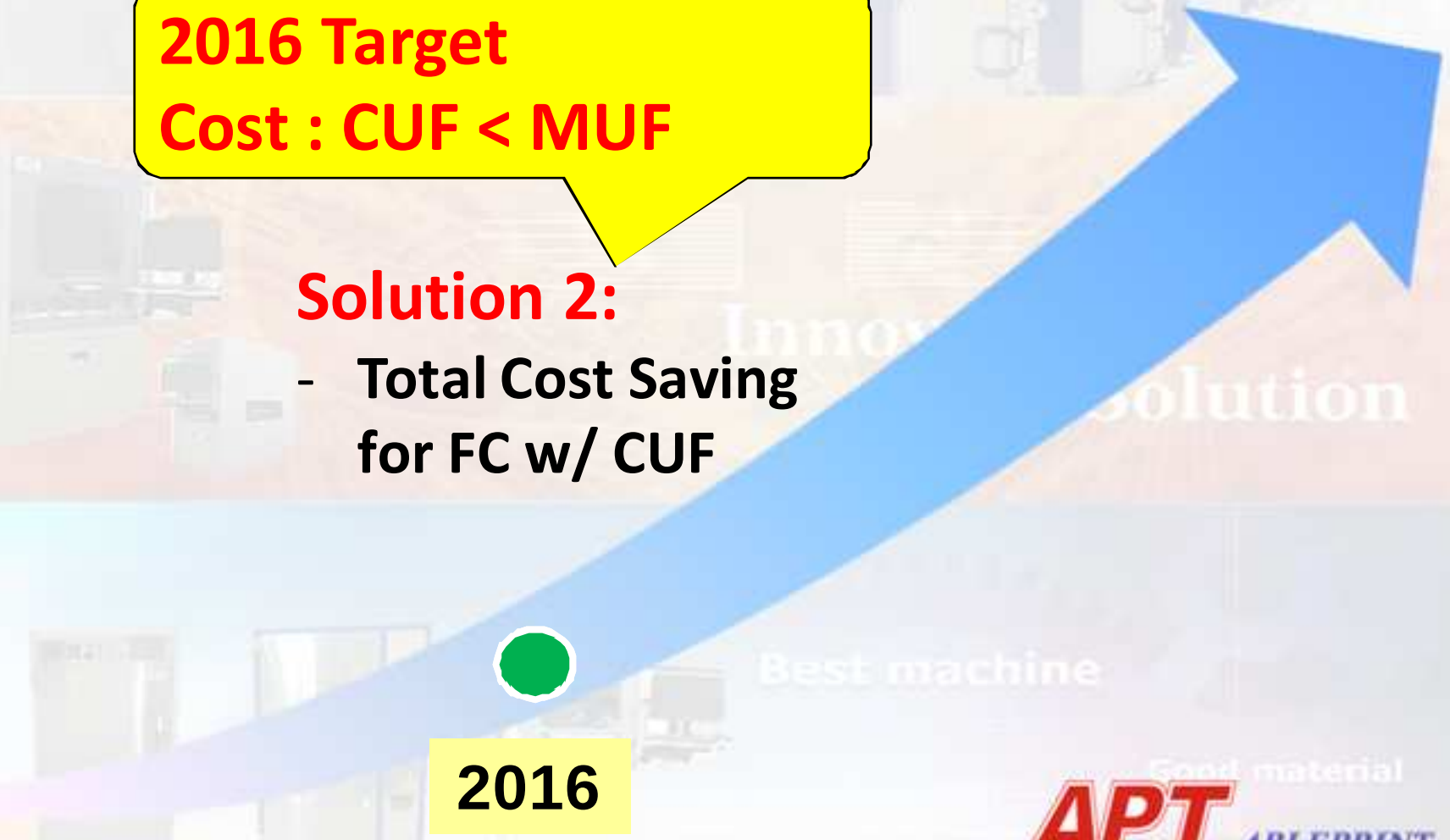
APT Product & Process Roadmap

2016 Target
Cost : CUF < MUF

Solution 2:

- **Total Cost Saving for FC w/ CUF**



Things are happening in 2016

for

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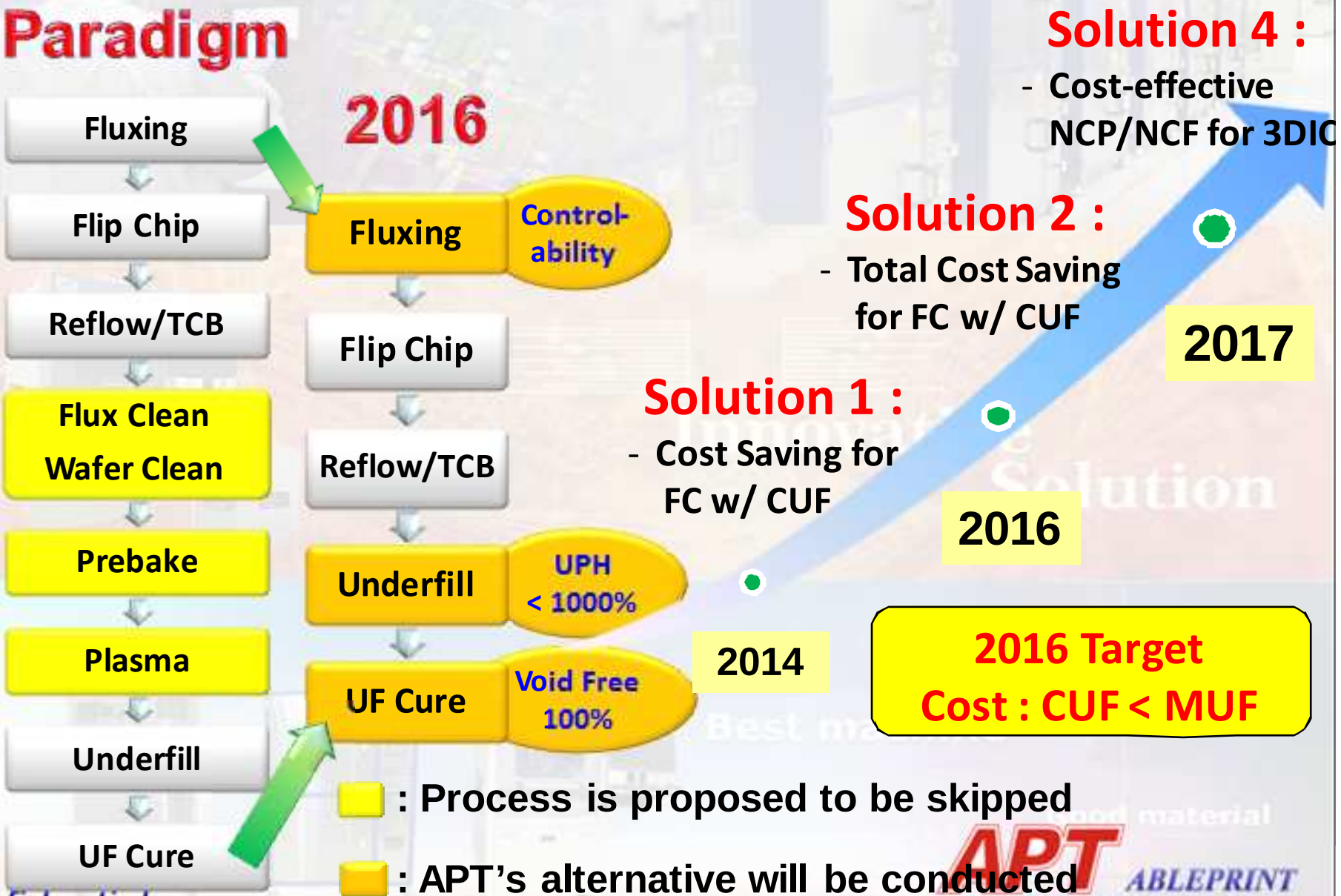
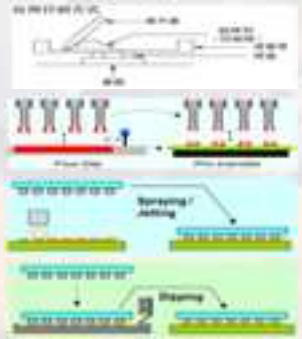
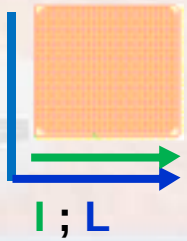
CUF Cost Saving Approach



Flip Chip Cost Saving Solution

	Paradigm	APT	Merit
Flux		New Flux Coating Method	Efficiency very few residue
CUF Underfill			Dispenser UPH 30%~1000% enhancement
CUF Cure	Normal Oven	Void Terminator System	Dissolve & Diffuse - No flux clean - No pre-bake - No plasma - Extend Q time

Operation Cost Estimation

~~Flux Residue Cleaning~~ ~~Water Cleaning~~ ~~SBT Baking~~ ~~Plasma Cleaning~~

Baking & Cleaning

Dispenser (CUF)

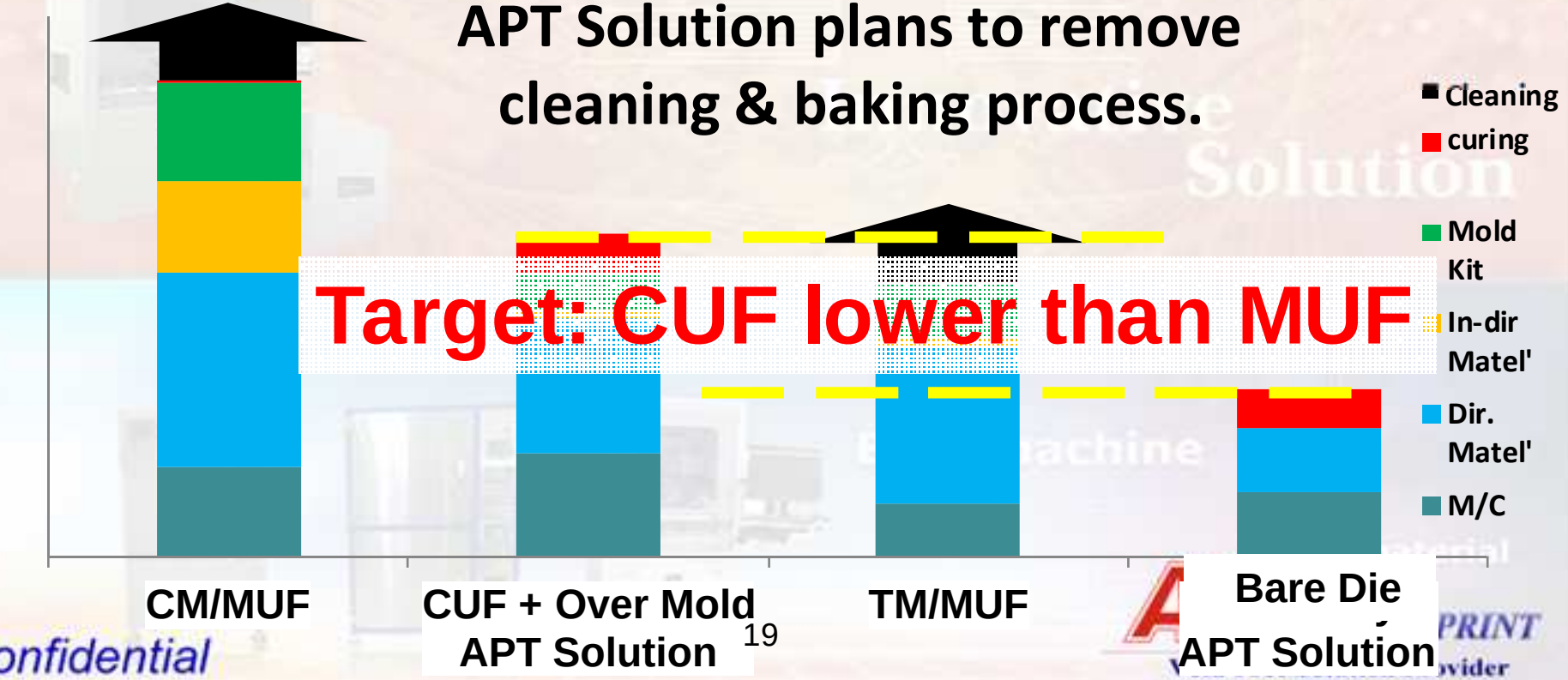
Dispenser + TM(CUF + MD)

Oven Curing

TM: Transfer Mold
CM: Compression Mold

part2.2016 : CUF Solution

APT Solution plans to remove cleaning & baking process.



Innovated Alternative

MIJ: Map InkJet Printer

hundreds nozzles

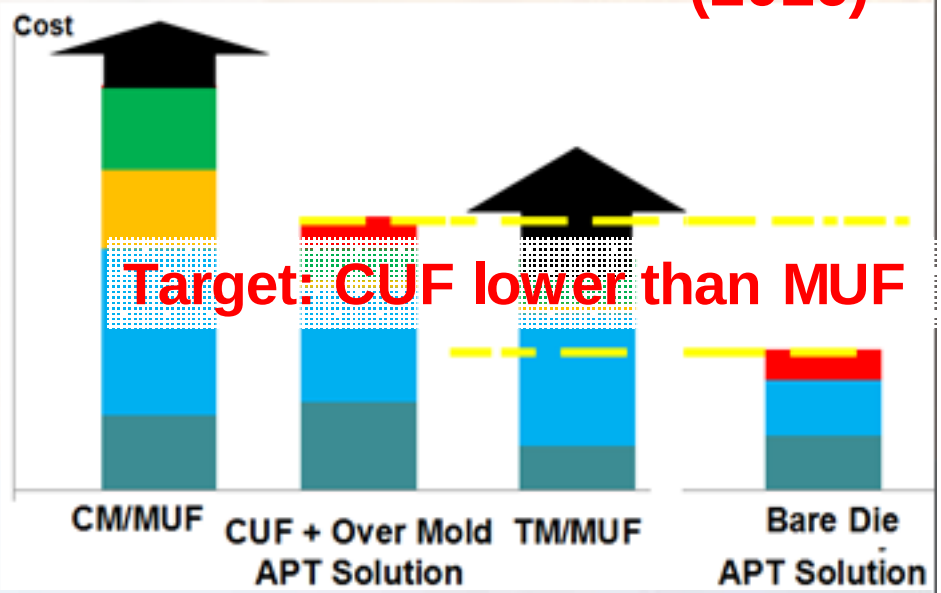
Precise position and volume flux control

MIJ

No need flux clean

No contamination on die top

Operation Cost Comparison (2016)



Best machine

Good material

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CUF Solution

Phases to Approach

APT's Support

【Project】

Capillary Underfill void free with pressure oven VTS assisted for Cost Reduction and Quality Improvement.

【Sequence Proposal】

- **Phase 1** : - Enhance dispenser throughput;
  - Remove substrate baking
  - Extend Q time;
  - Shorten devoid_cure time
- **Phase 2** : - Flux residue cleaning;
- **Phase 3** : - Remove plasma cleaning process;

Phase 1– UPH Enhancement

Case 1

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- ✓ Chip :
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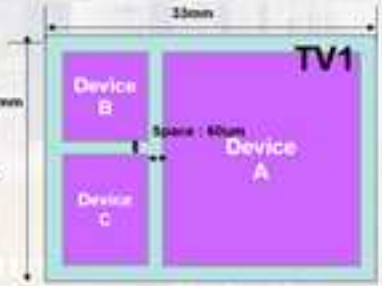

Experiment arrangement and result

✓The dispensing pattern is fixed as U+□ and dispensing time is enhance from

540sec/pkg to 45sec/pkg.

UPH x10

Case 2

Product : TCCUF

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  - Gap chip&sbt 20~30um
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✓U pattern

UPH x9.5

✓MCL pattern

Case 4

TV4

Condition	Before Cure	After Cure	Remark
With Normal oven			Still has small void

UPH x7.5

APT VTS (Skip plasma & pre-baking)

No void

UPH (190sec → 25sec)

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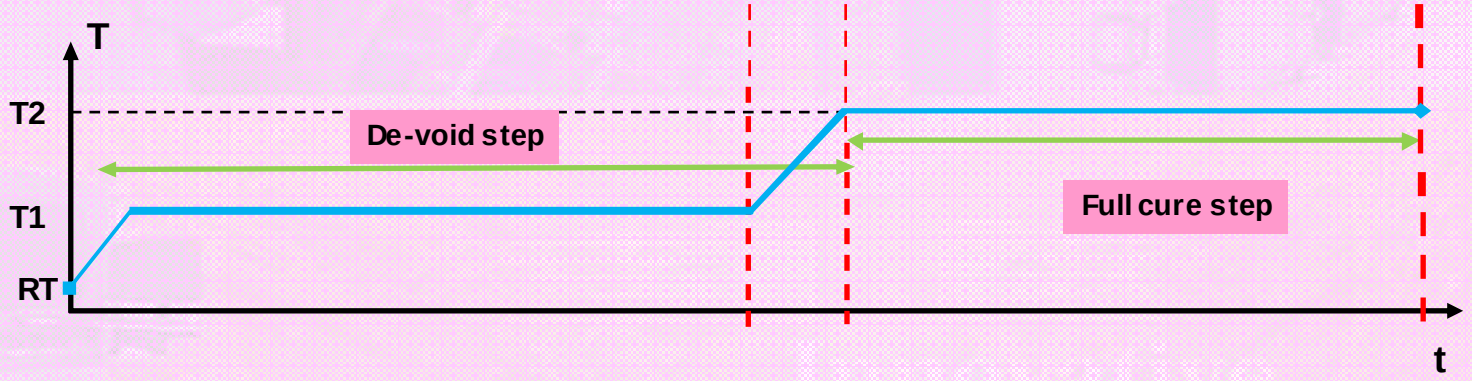
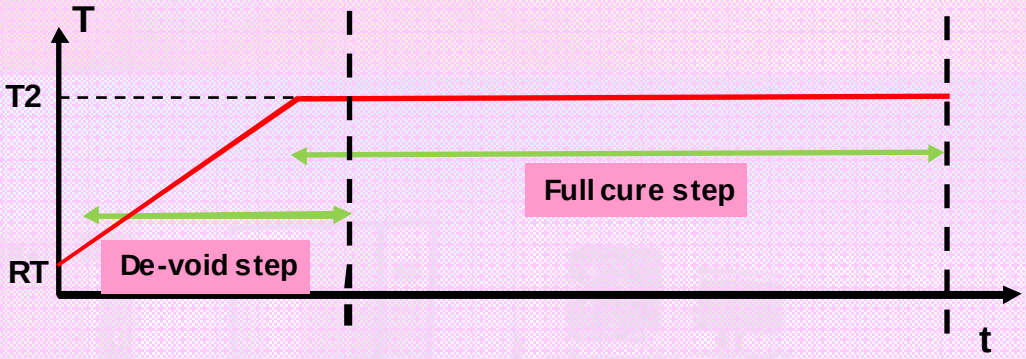
Confidential

Phase 1 – Extend Q & Shorten Devoid Time

2 Steps: paradigm VFS profile

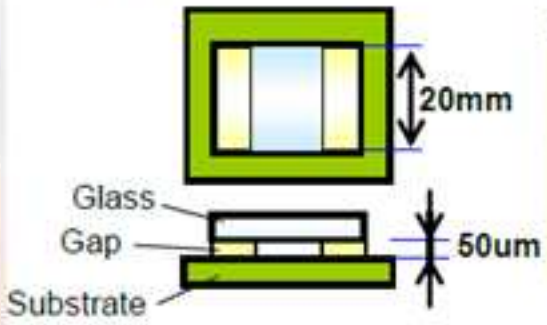


1 Steps: cost effective VFS profile



Phase 1 – Substrate Prebake

·*Test piece*



UF : U8410-73C
Moisture condition: 25C / 50% 3hrs
Stage temperature: 110C

Before cure

Ramp up (150C,2hrs)

After cure

Oven

Moisture voids occur.

Pressure-oven

Voids disappear.

Phase 2 – Flux Residue

NAMICS

Mutual prosperity to both mankind and nature through Creativity, Innovation and Sensitivity

Flux compatibility and Adhesion strength with flux residue

Flux Compatibility Study

Henkel

Proposal

APT would like to contribute our innovation solution to go together with customer to make the best cost reduction happen.

Conclusions

- **VTS achieves cost down by**
  - Dispenser UPH Boost up
  - CUF usage is efficiency
  - Flexible Dispenser available
  - Better yield
- **VTS achieves better yield by**
  - Simplifying assembly difficulty
  - Minimizing process stress
  - Extending process capability
- **VTS extends process capability by**
  - Void free guaranteed regardless of fine pitch/gap flip
  - Well control bleeding and creeping
  - APT roadmap supports low pressure for Low K device/wafer.
  - APT even drives to realize non-Clean/Bake/Plasma process to industry.

Thanks you.