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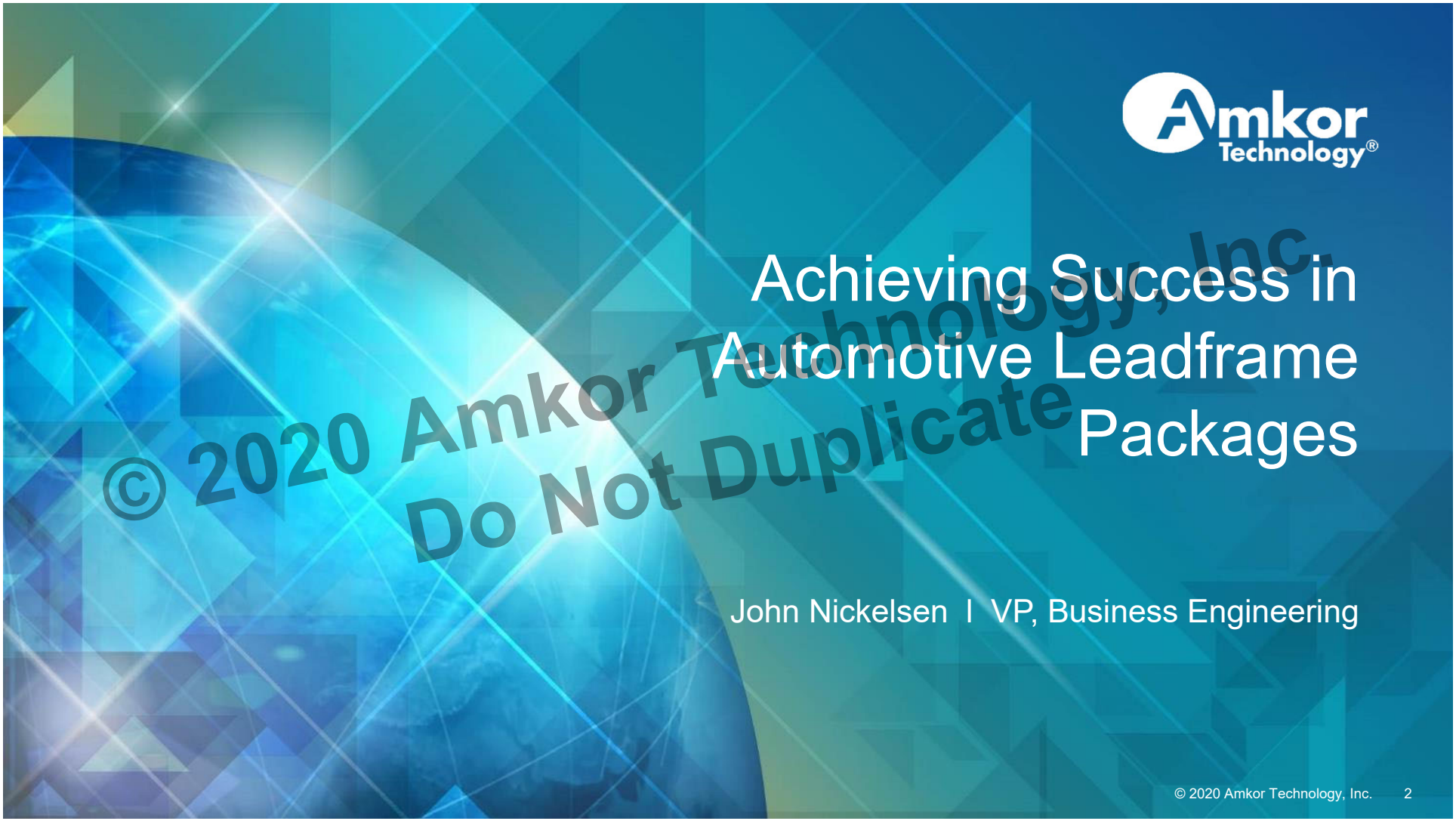
Amkor Technology®
Achieving Success in Automotive Leadframe Packages
John Nickelsen I VP, Business Engineering
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Agenda

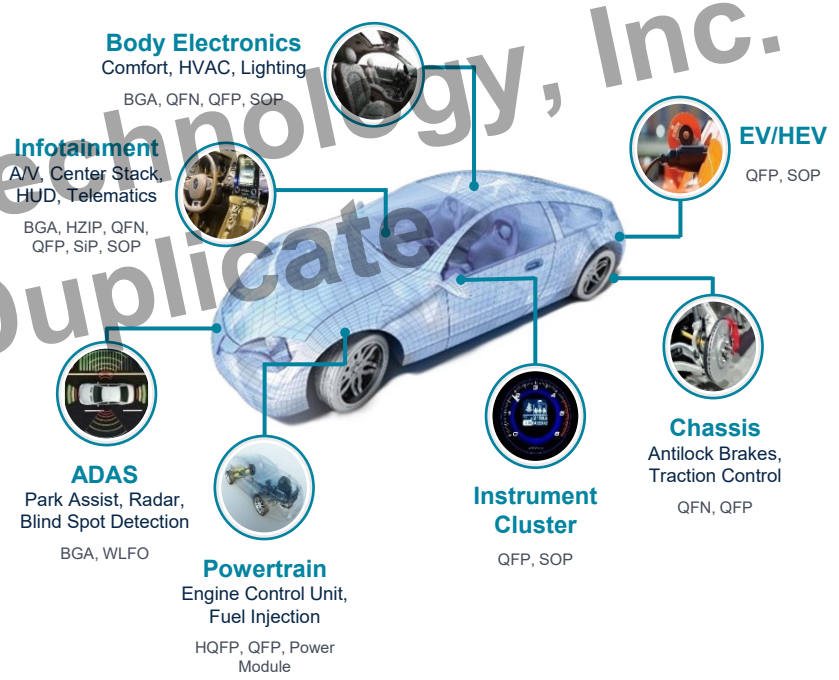
1. Introduction
2. Zero Escaped Defects
3. Zero Delamination
4. Wrap Up

Achieving Success in Automotive LF Packages

Amkor is # 1

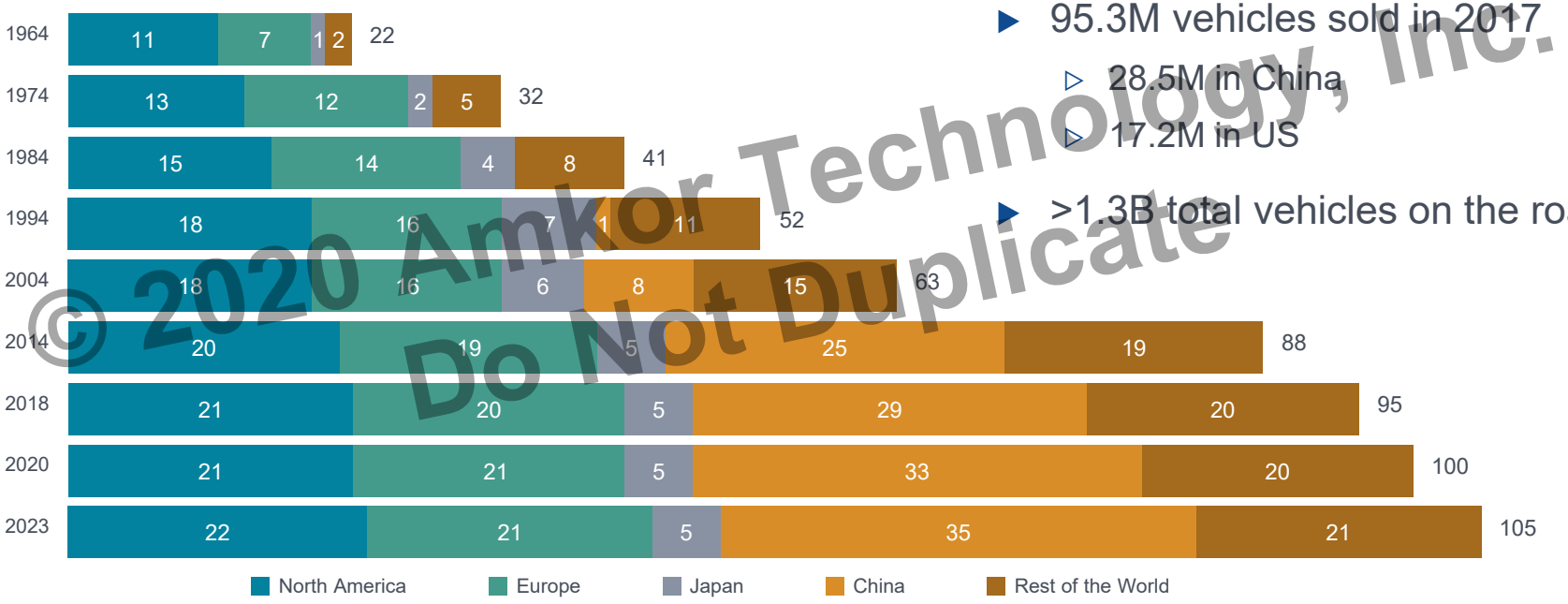
Accepted defects 0

Delamination 0



Automotive Unit Sales Growing

(Units in millions)



- 95.3M vehicles sold in 2017
  - 28.5M in China
  - 17.2M in US
- >1.3B total vehicles on the road

Source: IHS Automotive/Polk; Ward's Auto InfoBank; McKinsey analysis


Amkor #1 OSAT
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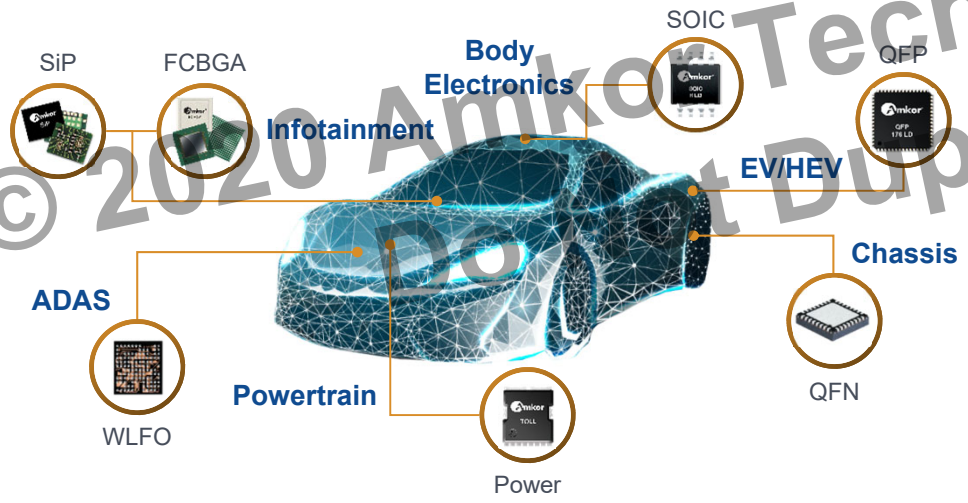
Amkor Enabling New Applications in the Car

Largest Automotive OSAT

Advanced Packages

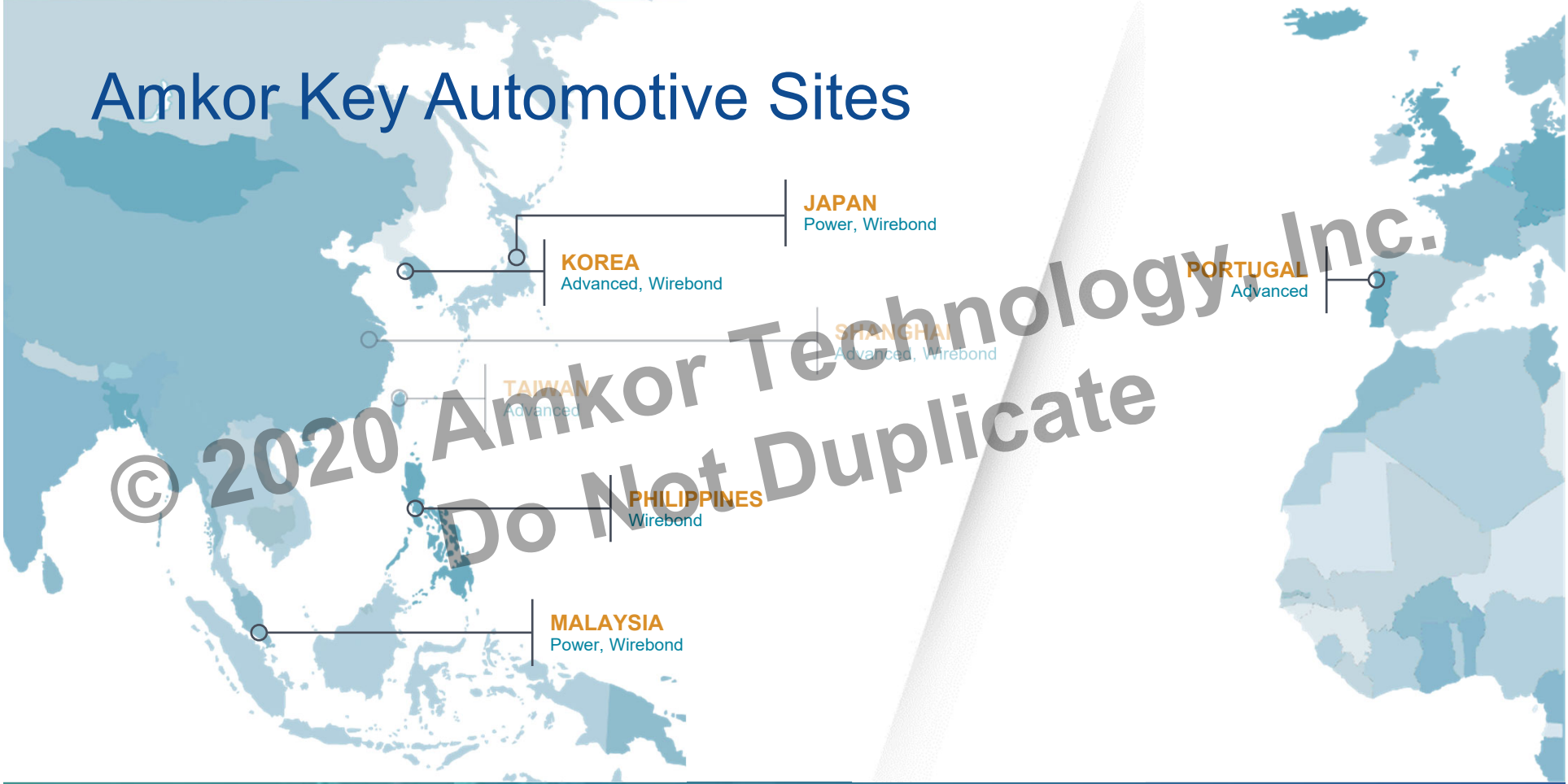
Wirebond Packages



Value Propositions

- >40 yrs of Automotive experience
- QualityFIRST mindset
- Leader in advanced Automotive packaging

Amkor Key Automotive Sites




Achieving Zero Escaped Defects
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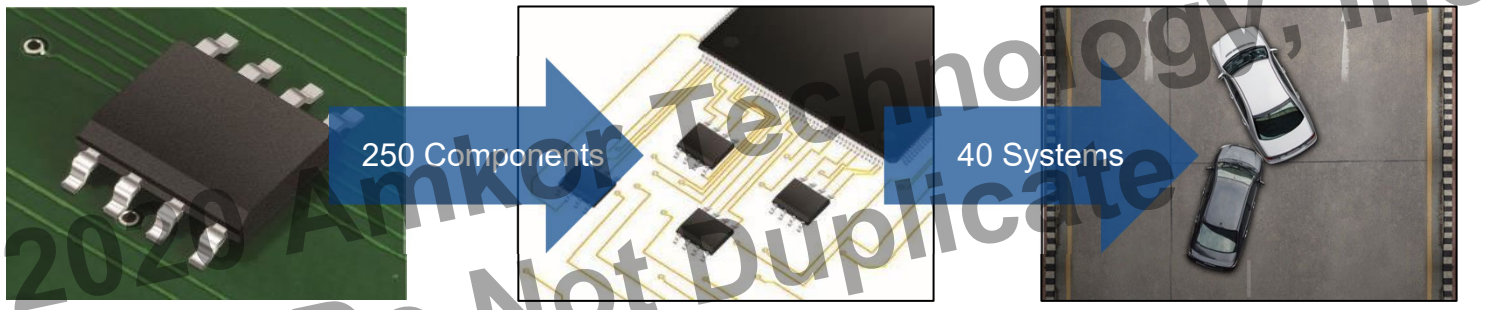
Prevent the Multiplier Effect



Too High	1 ppm	250 ppm	10,000 ppm (1.00%)
Target	~0 ppm	10 ppm	400 ppm (0.04%)

Automotive Capable Manufacturing Line

- MES set up verification
  - Equipment healthy, all parameters nominal
  - Correct program downloaded
  - Correct tooling
  - Correct BOM
  - Certified operator

Automotive Capable Equipment

- Run time verification
  - Correct product entered work area within acceptable processing time
  - All process steps successfully completed
  - Equipment auto inspection
  - All exceptions logged, if defect occurs, electronic defect map updated

Die Attached

No die, Insufficient coverage – Unit mapped defective

Wirebonder

NSOP, NSOL or missing wire – Unit mapped defective

Automotive Process Enhancements

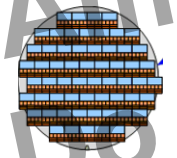
- Prevent escapes
- Fast feedback on defects to drive improvement

2D Strip/ Unit Mark

- Trace units through assembly
- Prevent strip mixing
- Support reject mapping

+

Die Traceability



- Link die to leadframe strip location

+

AOI 3rd Optical Inspection

- Replace manual inspection
- Detect wirebond defects

+

Open/Shorts Testing

- Detect wire defects from mold
- Immediate feedback on maverick lots

+

AOI Final Visual

- Replace manual inspection
- Detect microcracks


Achieving Zero Delamination
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Achieving Zero Delamination

- Requires
  - High performance BOM elements with matched properties
  - Enhanced process flow and control
  - Robust design
- Developed and defined Standard Process Descriptions (SPD)
  - BOM
  - Process
  - Inspections
- Demonstrated capability of passing AEC Q100 or Q006 Grade 0 with zero delam

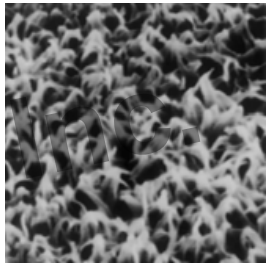
SOIC 150 mil body 8 ld
AEC Q006 Grade 0 Results

Test Item	Reading Point	Before /After	Delamination - EP25-MC31	T1	T2	T3	T4	T5
L1	260C 3X	Before	Qty	0	0	0	0	0
			Min	0	0	0	0	0
			Max	0	0	0	0	0
		After	Qty	0	0	0	0	0
			Min	0	0	0	0	0
			Max	0	0	0	0	0
L1	260C 3X	Before	Qty	0	0	0	0	0
			Min	0	0	0	0	0
			Max	0	0	0	0	0
		After	Qty	0	0	0	0	0
			Min	0	0	0	0	0
			Max	0	0	0	0	0
T/C	1500X	After	Qty	0	0	0	0	0
			Min	0	0	0	0	0
			Max	0	0	0	0	0
T/C	3000X	After	Qty	0	0	0	0	0
			Min	0	0	0	0	0
			Max	0	0	0	0	0
L1	260C 3X	Before	Qty	0	0	0	0	0
			Min	0	0	0	0	0
			Max	0	0	0	0	0
		After	Qty	0	0	0	0	0
			Min	0	0	0	0	0
			Max	0	0	0	0	0
HAST	96 hrs	After	Qty	0	0	0	0	0
			Min	0	0	0	0	0
			Max	0	0	0	0	0
HAST	192hrs	After	Qty	0	0	0	0	0
			Min	0	0	0	0	0
			Max	0	0	0	0	0
HTS	1000hrs	Before	Qty	0	0	0	0	0
			Min	0	0	0	0	0
			Max	0	0	0	0	0
		After	Qty	0	0	0	0	0
			Min	0	0	0	0	0
			Max	0	0	0	0	0
HTS	2000hrs	After	Qty	0	0	0	0	0
			Min	0	0	0	0	0
			Max	0	0	0	0	0

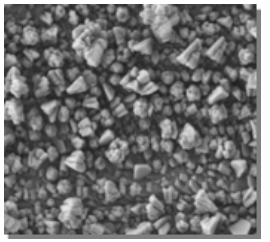
High Performance BOM

- Latest generation of die attach epoxy and mold compound provide superior performance
  - Improved epoxy systems
  - Changes to filler shape and size
- High performance leadframe roughening
  - Oxide
  - Additive
  - Subtractive
- Worked with key suppliers to develop a matched set of DA & EMC materials that when combined with the correct leadframe achieve zero delam after AEC Q006 Grade 0 testing

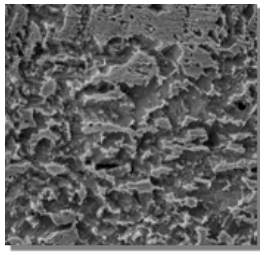
Leadframe Roughening



Oxide



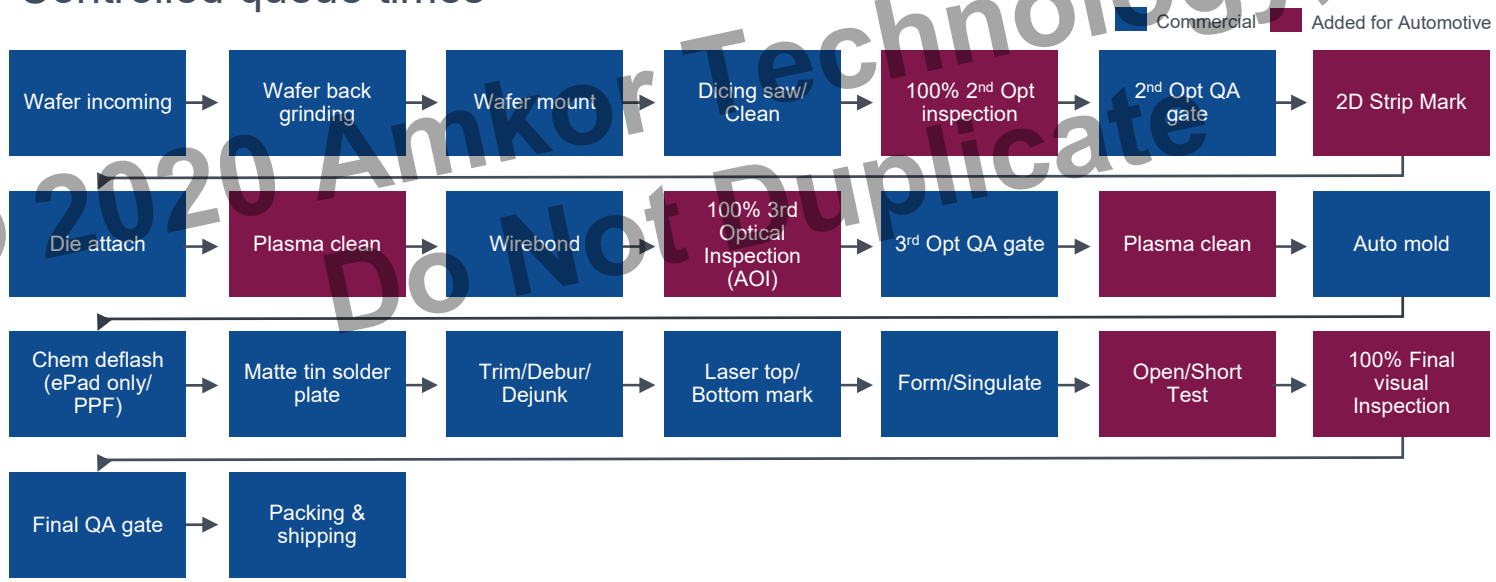
Additive



Subtractive

Automotive Process Flow

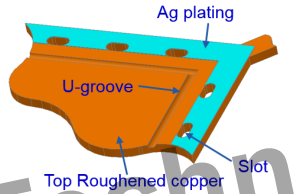
- Process flow
  - Automotive specific steps & inspections
  - Controlled queue times



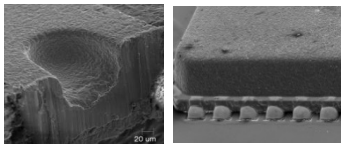
Design Features for Automotive

- Enhanced design
  - Leadframes with stress relief and plated features
    - Leadframes with locking slots
    - U-Grooves
  - Adhesion promoters
    - Roughening most effective
      - With roughened plating
  - MLF®
    - Plated End Lead (PEL) MLF®
      - pMLF® – dimple wettable flank
      - sMLF® wettable flank – step cut
    - pMLF® Edge Protection™ Technology

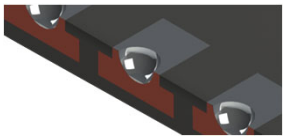
Edge Protection™ Technology



Step Cut



Wettable Flank



Dimple


Wrap Up
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Achieving Success in Automotive

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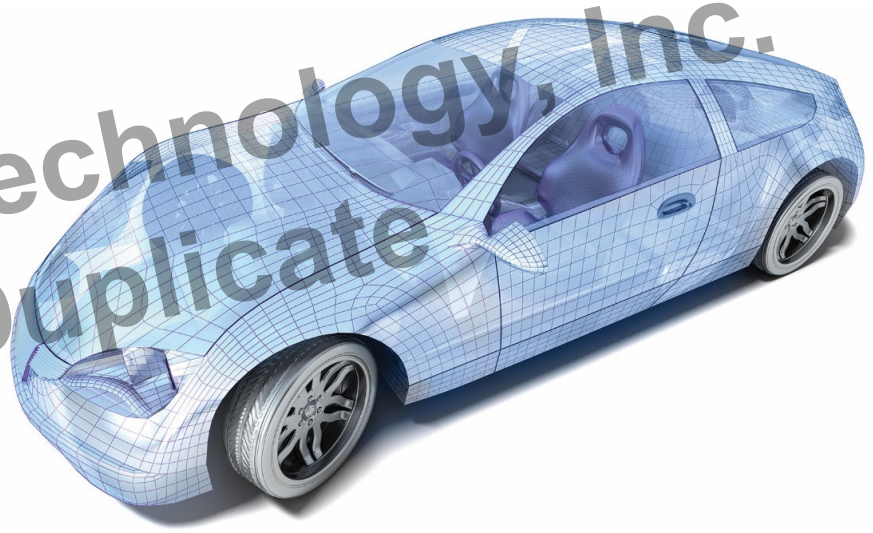
Accepted defects 0

Delamination 0

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