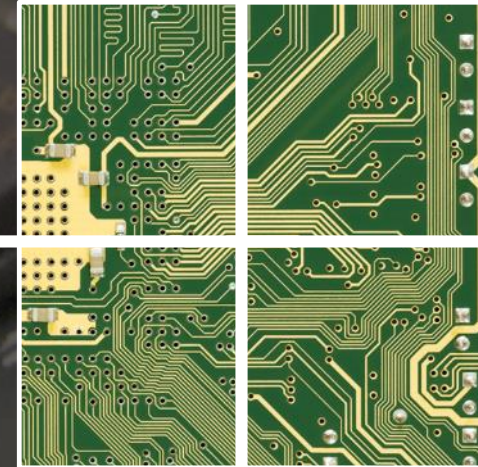


# Affinity 2.0 Electroless Nickel – Immersion Gold

REDUCING COST – REDUCING CORROSION !!!

Andrew Barlow  
September - Hayling ICT



# Affinity 2.0

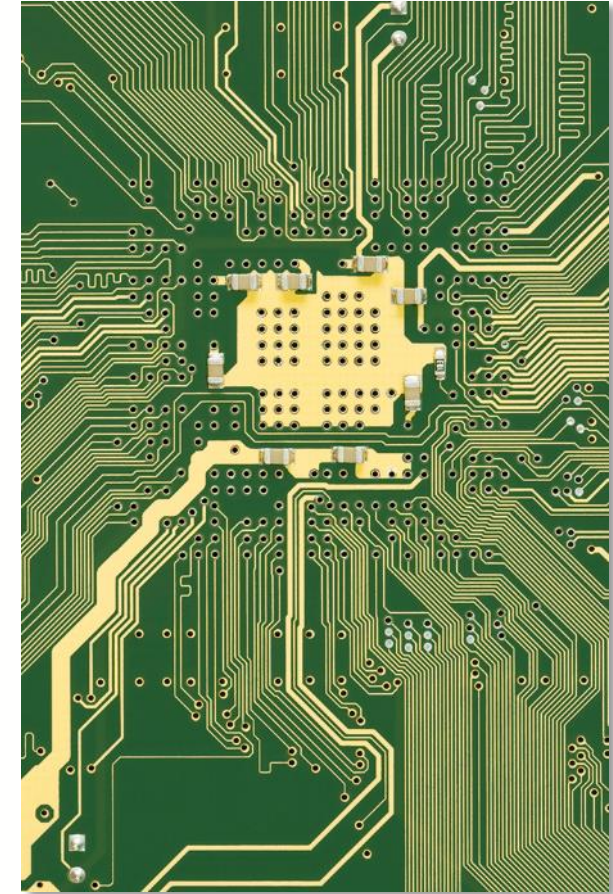
## Agenda

- Why Affinity ENIG 2.0?
- ENIG Corrosion.
- Six Sigma Process Engineering.
- Gold Thickness Control and Distribution.
- Value Proposition Calculator.
- Technical Proposal.

# Affinity ENIG 2.0

Reduced Variation - Higher Yield – Lower Operating Cost

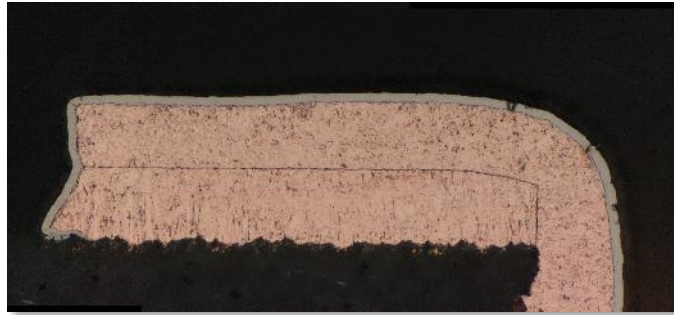
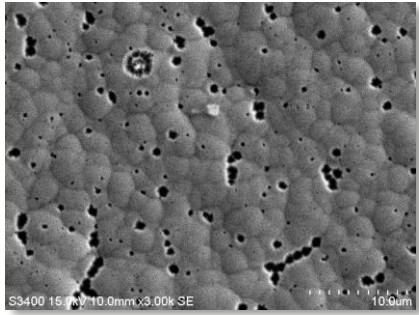
- **Affinity ENIG 2.0:** developed from lead ENIG technologies from newly integrated companies with new innovations from collective expertise.
- **EN Corrosion**
  - EN corrosion removed from the process eliminating concern and discussion with end users and OEM's.
- **Six Sigma Development**
  - Defects and wastes driven out during development.
  - Process variation minimized in production.
- **The Lowest Gold Metal Operating Cost**
  - Low panel-to-panel and feature-to-feature gold thickness variation provides significant opportunity for operating cost reduction.



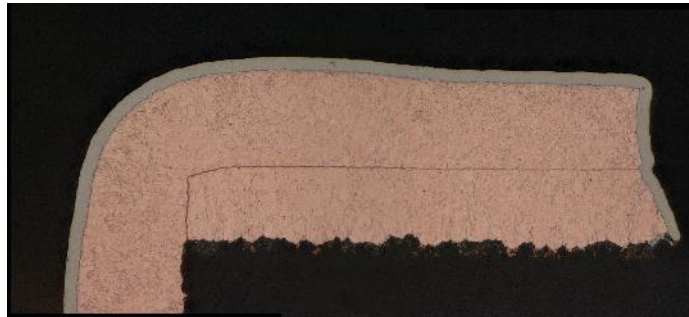
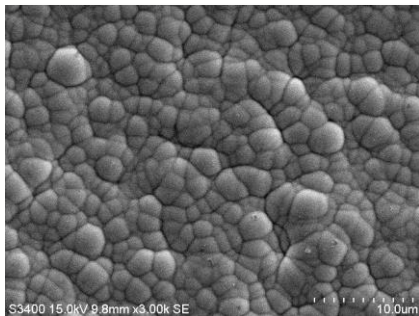
# Affinity ENIG 2.0

## Technology Benefits- Corrosion Control

### Traditional ENIG



### Affinity 2.0



- Immersion gold mechanism involves galvanic displacement of nickel ions from the EN surface.
- The point at which EN corrosion leads to reliability concerns is debated, but this concern is reduced significantly with Affinity 2.0.
- PCB fabricators and end users continue to become more critical of ENIG corrosion, this is reflected in the recent revision A of IPC4552.
- **Affinity ENIG 2.0 has been developed with these concerns in mind, delivering low and consistent corrosion occurrence.**



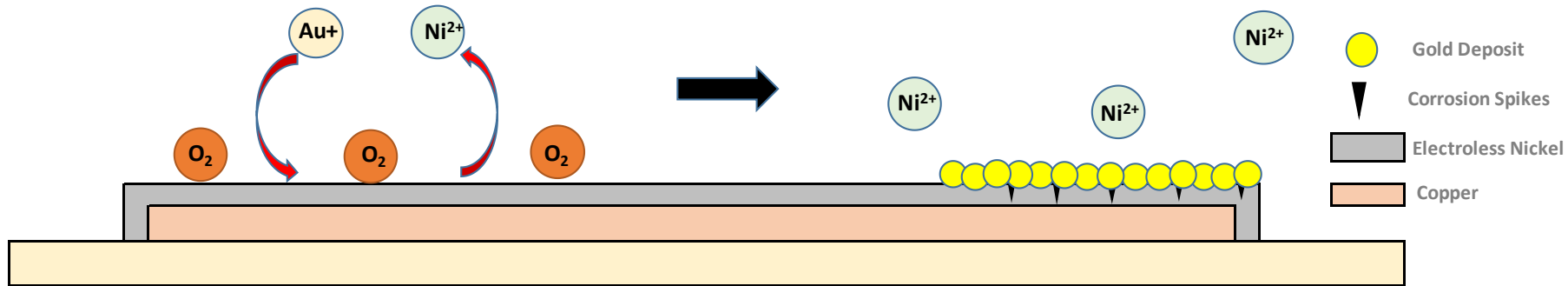
# Affinity ENIG 2.0

## Optimization of Galvanic Displacement Reaction

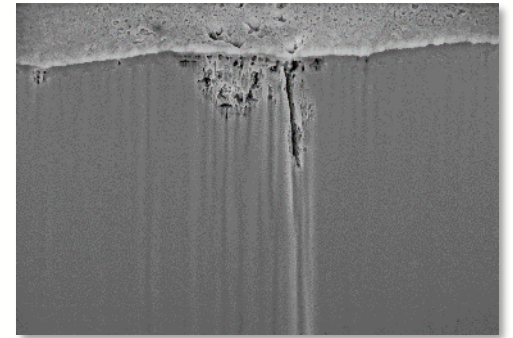
### Traditional ENIG - Galvanic Displacement Reaction

- 1a. Replacement of Ni from EN surface with Au ion (electron transfer) proceeds.  
1b. Oxidation of the EN surface can occur simultaneously.

2. Gold deposit forms with spikes of corrosion.



### Traditional ENIG



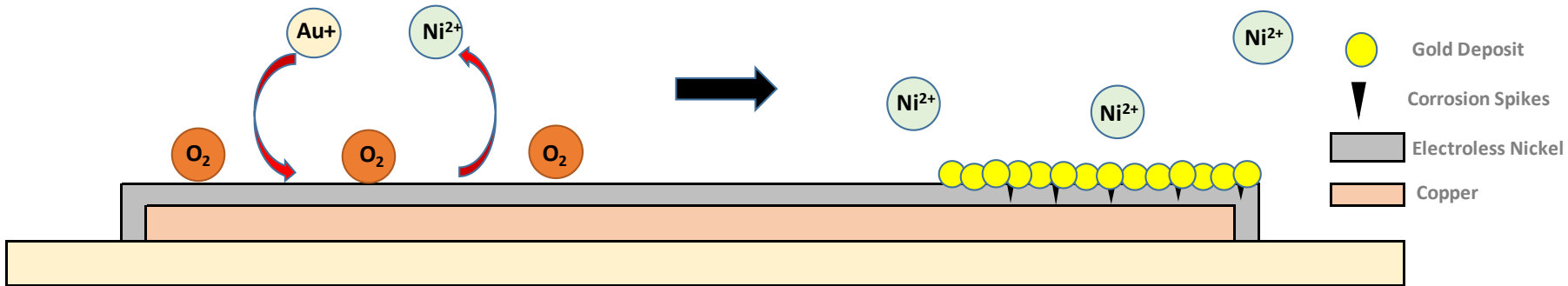
# Affinity ENIG 2.0

## Optimization of Galvanic Displacement Reaction

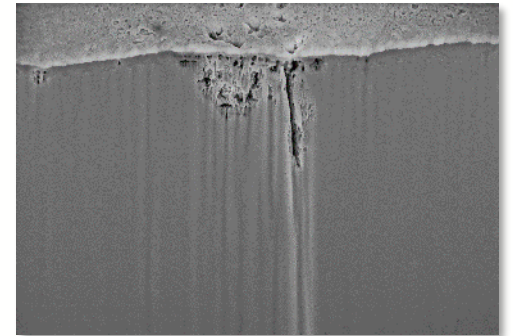
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### Traditional ENIG

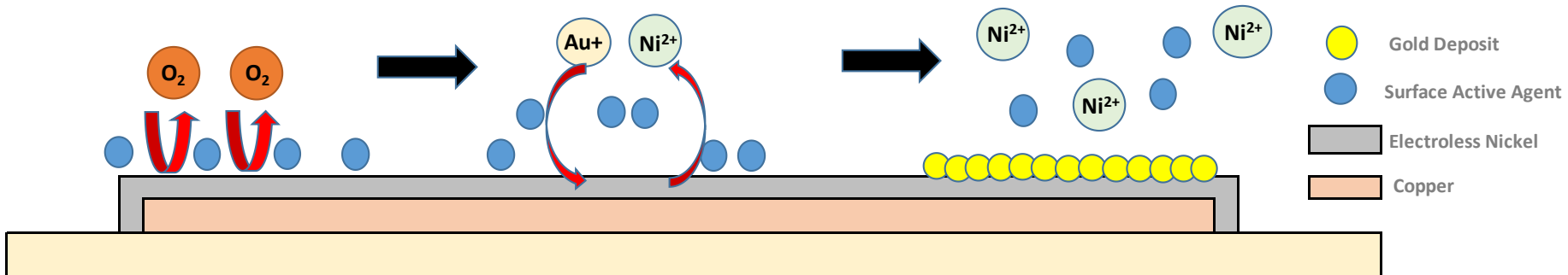


### Affinity 2.0 ENIG - Controlled Galvanic Displacement Reaction

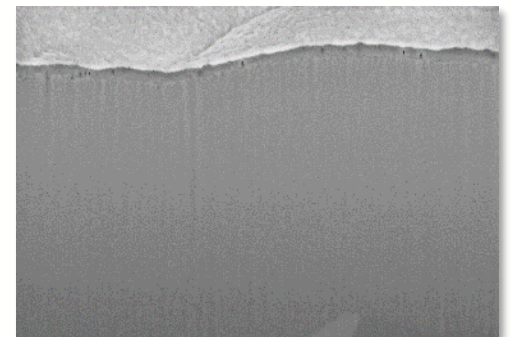
1. Surface Active Agent adsorbs on EN surface preventing nickel oxidation / corrosion.

2. Surface Active Agent desorption allows controlled replacement of Nickel with Gold.

3. Controlled replacement of nickel with gold proceeds by repeating stages 1 and 2.

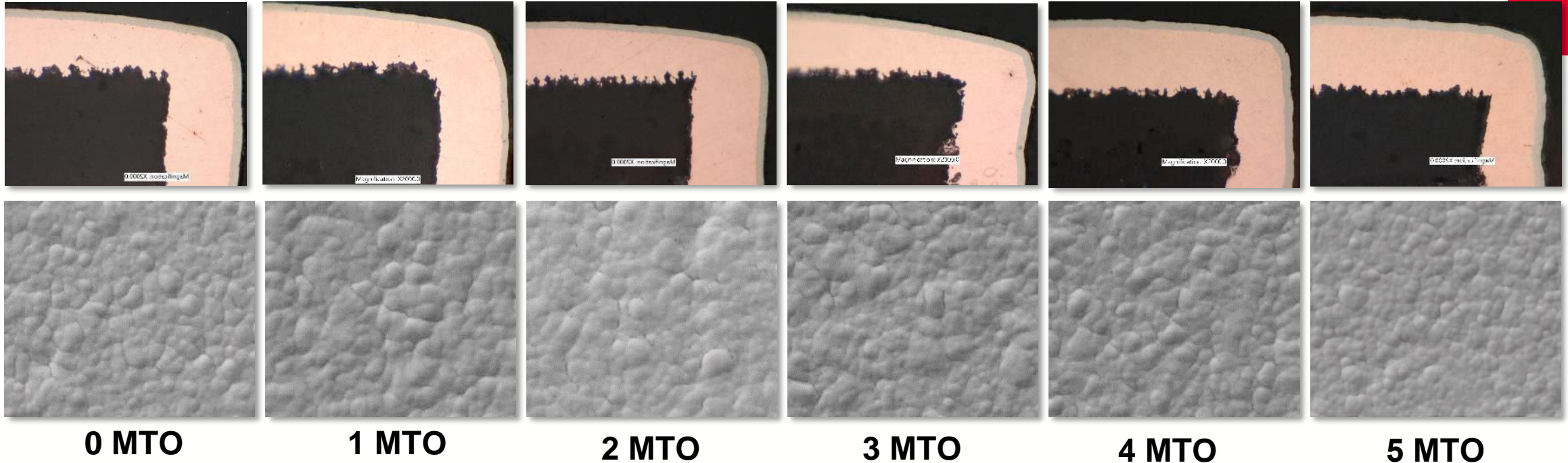


### Affinity ENIG 2.0



# Affinity ENIG 2.0

## Technology Benefits – Corrosion Control After Gold Stripping



- Affinity ENIG 2.0 provides excellent corrosion observations by X-Section and SEM following gold stripping.
- PCB Fabricator and End Users will observe consistent and low occurrence of corrosion.
- Eliminate concern and discussion over reliability associated with traditional ENIG systems.

# Affinity ENIG 2.0

## Technology Benefits – Six Sigma Development



### What is Six Sigma and why is it important to your business?

*“The Six Sigma strategy is a systematic, data driven approach to problem solving. Six Sigma tools are widely recognized in a variety of industries for their proficiency at reducing defects and driving process improvement.*

*A six sigma process produces only 3.4 defects per million opportunities!*

### We already have a 99% ENIG yield, why would we care about Six Sigma ?

(1) During 2016 Hong Kong International Airport operated an average of 1,100 flights per day!

- 99% success would mean 11 air disasters every day!!!

(2) A PCB Fabricator produces 5,000 panels per day with a 99% ENIG yield !

- 99% yield would mean 14,500 scrap panels per year (based on 290 working days per year).

**Six Sigma’s vast tool kit was used throughout research, alpha and beta test phases of Affinity ENIG 2.0.**

**MacDermid Enthone’s Six Sigma green and black belts will bring these benefits to your factory.**



# Affinity ENIG 2.0

## Gold Thickness Control: Ability to meet Specification



Table 3-1 Requirements of Electroless Nickel Immersion Gold Plating

Tests	Test Method	Requirement Paragraph	Class 1	Class 2	Class 3
<b>General</b>					
Measurement Capability	XRF		Gage capability $C_g \geq 1.33^{(1)}$		
XRF Thickness Sample Size	XRF	3.5.3.2	$C=0$ with n (minimum) = $[2 / C_g]^2$ as necessary		
Visual	Visual	3.3	Uniform plating and complete coverage of surfaces to be plated		
Electroless Nickel Thickness Rigid Printed Board	Appendix 3	0.1	3 to 6 $\mu\text{m}$ [118.1 to 236.2 $\mu\text{in}$ ]		
Electroless Nickel Thickness Flex Printed Board <sup>(2)</sup>	Appendix 3	3.5.1.4	1.27 to 6 $\mu\text{m}$ [50.0 to 236.2 $\mu\text{in}$ ]		
Immersion Gold Thickness (Exception required on Procurement documentation)	Appendix 3	3.5.2.1	The minimum immersion gold deposit thickness shall be $\bar{x} - 3s \geq 0.04 \mu\text{m}$ [ $\geq 1.58 \mu\text{in}$ ] The maximum immersion gold deposit thickness shall be $\bar{x} + 3s \leq 0.1 \mu\text{m}$ [ $\leq 3.94 \mu\text{in}$ ] as measured on a pad size of 1.5 mm x 1.5 mm [0.060 in x 0.060 in] or equivalent area, $\pm 10\%$ . Where: $\bar{x}$ = the mean gold thickness s = the standard deviation of a sample		

### Revision A to IPC4552.

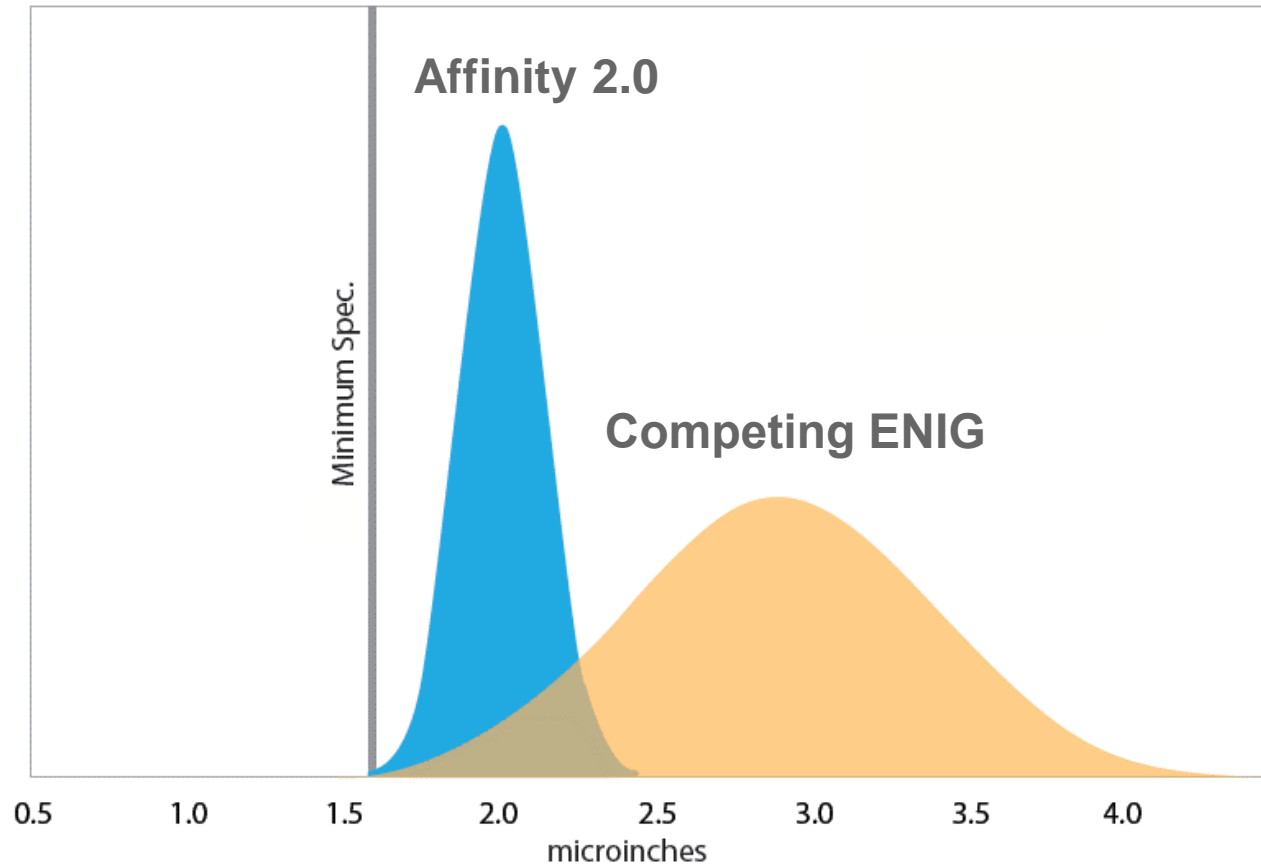
$$\bar{X} - 3s \geq 0.04 \mu\text{m} [\geq 1.58 \mu\text{in}]$$

$$\bar{X} + 3s \leq 0.1 \mu\text{m} [\leq 3.94 \mu\text{in}]$$

- IPC has added an upper specification limit for gold thickness
  - Addition of upper boundary increases need for Gold thickness control to maintain a capable process.
- IPC allows a lower average Gold thickness if good deposit distributions can be achieved.
  - This offers potential savings in gold metal consumption.

# Affinity ENIG 2.0

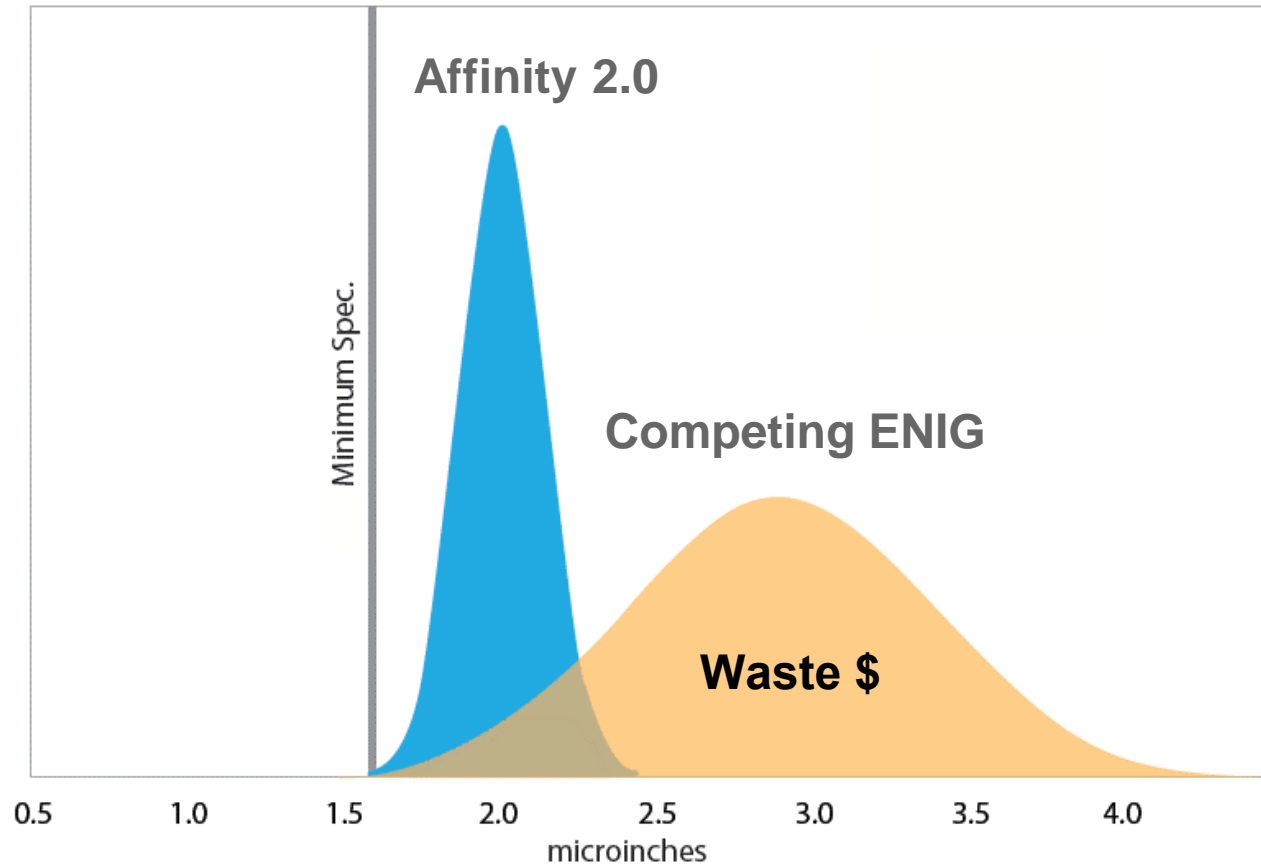
Understanding Variation: What Does Gold Distribution Mean For Savings?



- Some PCB fabricators only care about not exceeding a minimum specification gold thickness.
- **Poor gold thickness distribution = significant waste**

# Affinity ENIG 2.0

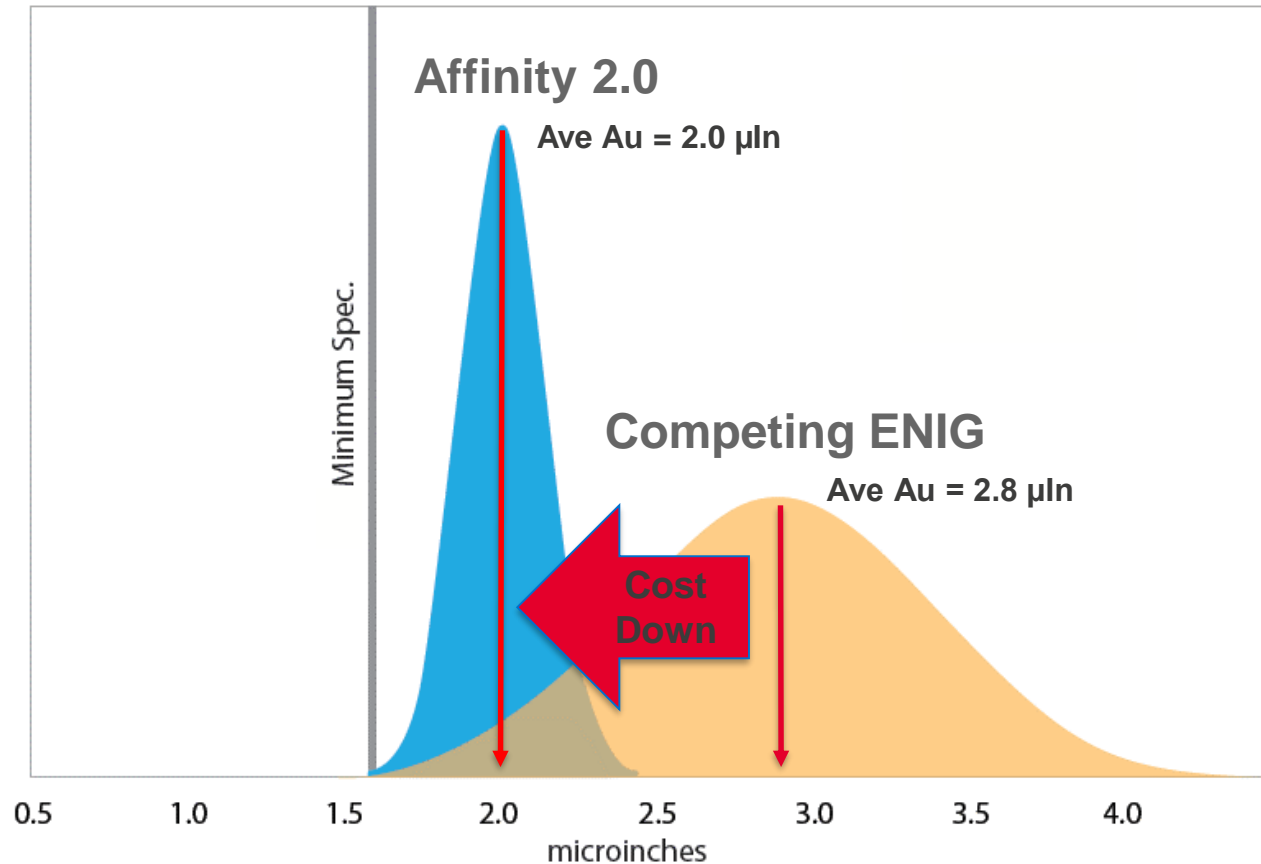
## Understanding Variation: What Does Gold Distribution Mean For Savings?



- Some PCB fabricators only care about not exceeding a minimum specification gold thickness.
- Poor gold thickness distribution = significant waste
- **Affinity ENIG 2.0 delivers significantly improved gold thickness distribution compared to competitive ENIG systems.**

# Affinity ENIG 2.0

Understanding Variation: IPC4552A - What Does Gold Distribution Mean For Savings?

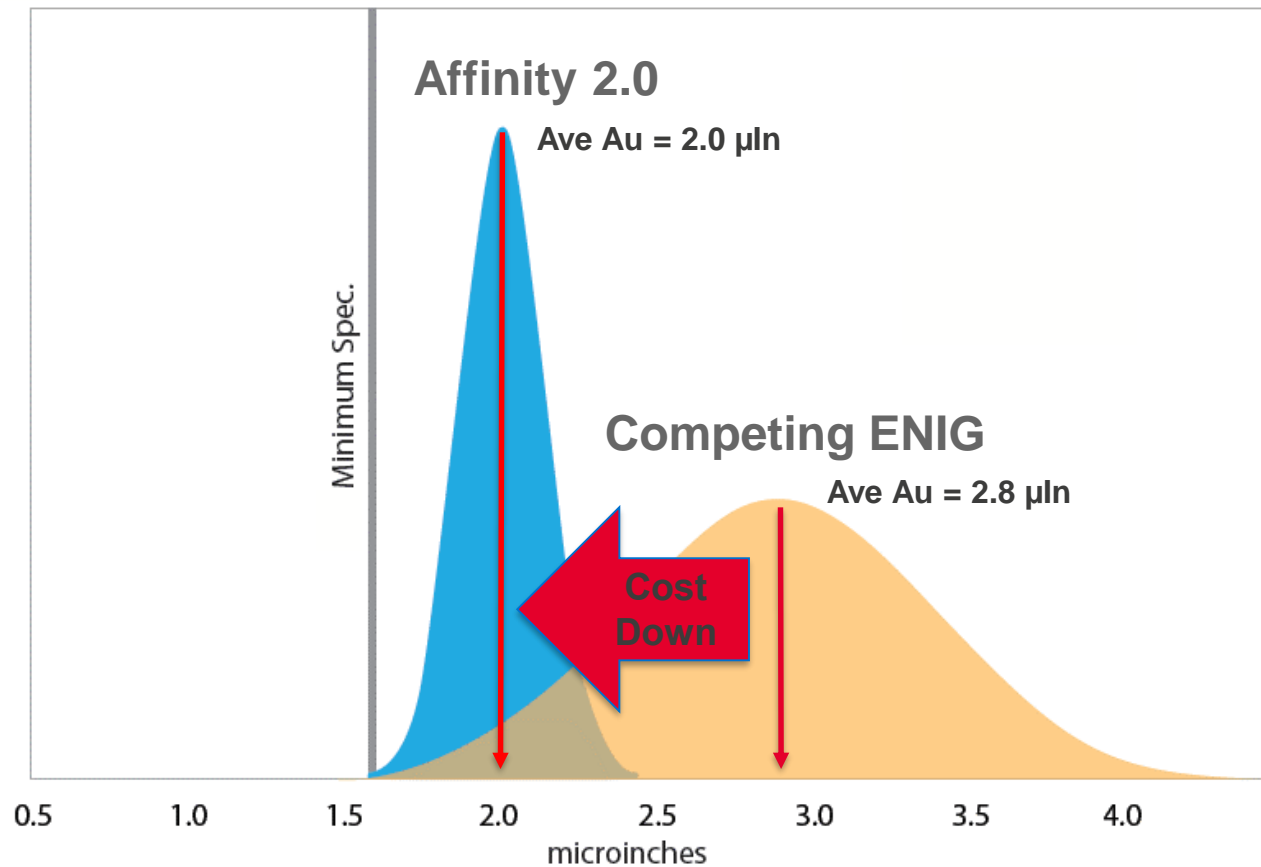


- Some PCB fabricators only care about not exceeding a minimum specification gold thickness.
- Poor gold thickness distribution = significant waste
- Affinity ENIG 2.0 delivers significantly improved gold thickness distribution compared to competitive ENIG systems.
- **IPC4552 Rev. A allows minimum gold thickness of 1.58 microinches at three standard deviations below the average thickness.**



# Affinity ENIG 2.0

## Understanding Variation: IPC4552A - What Does Gold Distribution Mean For Savings?



- Some PCB fabricators only care about not exceeding a minimum specification gold thickness.
- Poor gold thickness distribution = significant waste
- Affinity ENIG 2.0 delivers significantly improved gold thickness distribution compared to competitive ENIG systems.
- IPC4552 Rev. A allows minimum gold thickness of 1.58 microinches at three standard deviations below the average thickness.
- **This translates directly to cost savings for processes with tighter gold thickness distributions.**

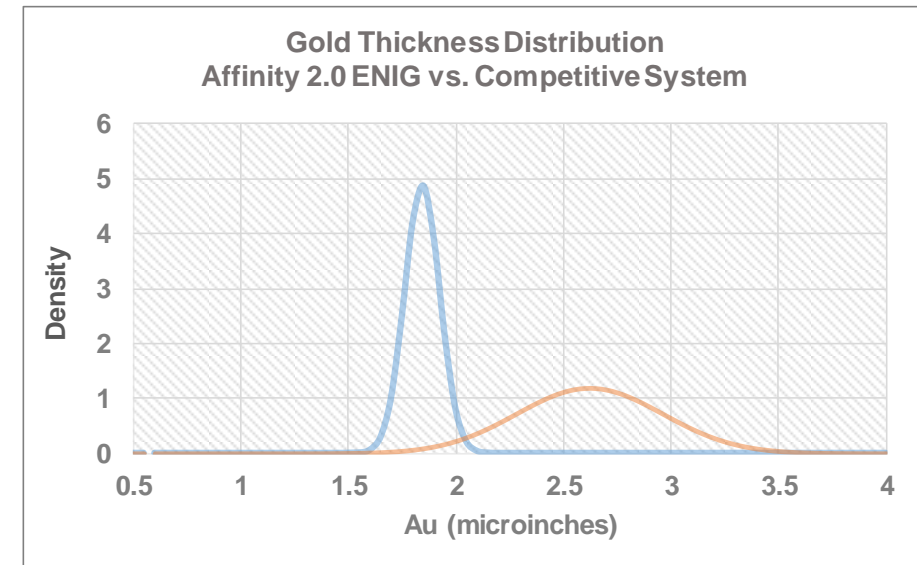
# Affinity ENIG 2.0 Case Study

## Technology Benefits – Average Gold Thickness Reduction / Cost Saving Calculation

Net Benefit in Gold Consumption Calculation			
	Incumbent	Affinity 2.0	
Minimum Gold Thickness	1.60		microinches
Gold Thickness Standard Deviation	0.3400	0.0815	microinches
Average Au Thickness	2.62	1.84	microinches
Gold Metal Consumed	0.0353	0.0248	gram /panel sq ft
Gold Metal Cost	\$1.33	\$0.940	\$ /panel sq ft
<b>Gold Consumption Reduction</b>	<b>29.59%</b>		
Product Estimate Month	125,000		
Monthly Saving	\$49,382.67		
Annual Saving	<b>\$592,592.07</b>		

**Au Metal \$/g** 37.85

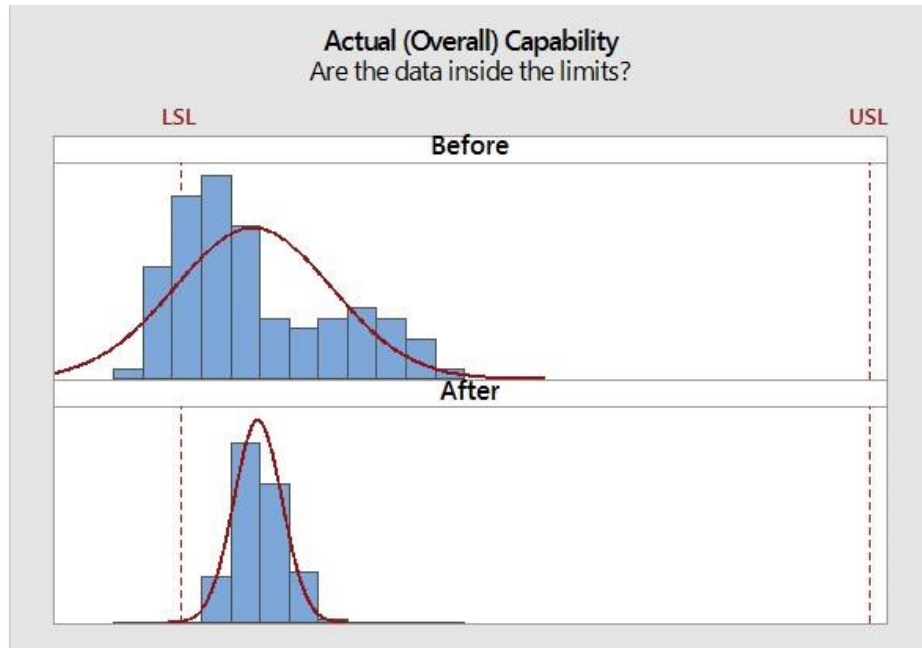
**Metal Area** 15.00%



# Affinity ENIG 2.0

## Technology Benefits – Case Study

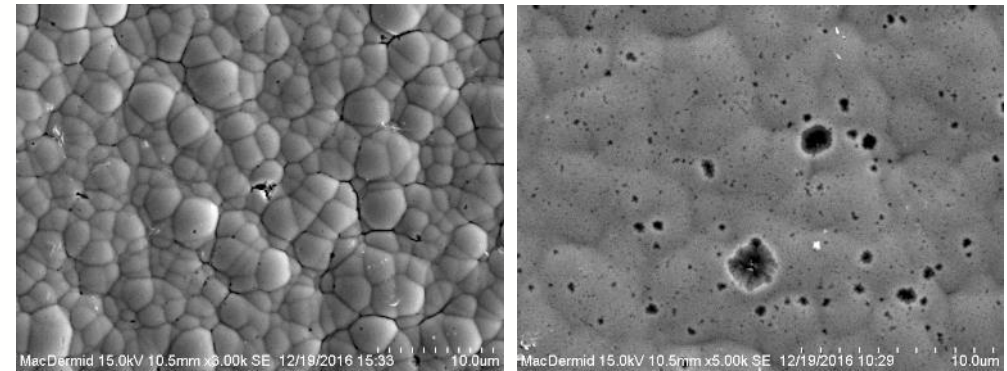
### Gold Thickness Distribution



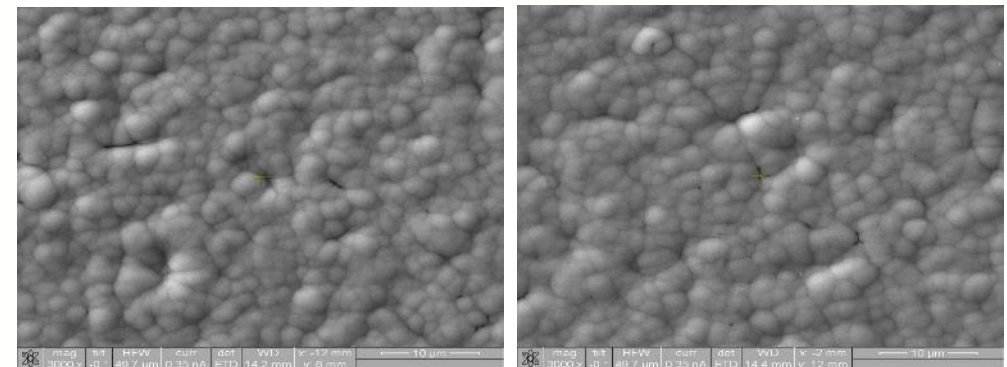
**100%**

**Reduction in % Out of Spec**  
% Out of spec was reduced by 100% from 17.80% to 0.00%.

### Incumbent ENIG Corrosion



### Affinity 2.0 Corrosion



# Affinity ENIG 2.0

## Proposal



MacDermid Enthone and customer agree to process standard test boards in current ENIG over a standard EN bath life for comparison to Affinity 2.0.



MacDermid Enthone will analyze the gold distribution, corrosion and other key attributes ENIG process **providing a report detailing cost reduction and benefits in switching to Affinity 2.0.**



MacDermid Enthone will process any test vehicles required by the customer through Affinity ENIG 2.0 and return them for evaluation.

**Affinity ENIG 2.0**  
Value Demonstration for PCB Fab XYZ

**Measurement System Evaluation**

**Corrosion Comparison**

**Electroless Nickel Phosphorous Distribution**

**Technical Service**

- Technical Experts
  - Our development and training programs ensure that our people understand our products at the deepest level.
  - Disposability
    - We understand that our customers operate within "JIT" supply chains.
- Local Technical Facilities
  - With local access to the latest analytical equipment, our customers can see us in depth service.
  - Application Know-How
    - MacDermid Enthone has over 80 years of know-how and experience embedded in our culture.

*"Service is the key to satisfying our customers, wherever they are in the world"*

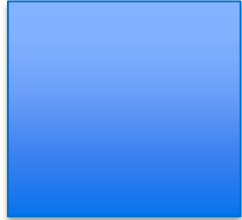
**MacDermid Enthone**  
ELECTRONICS SOLUTIONS  
A Platform Specialty Products Company



# Affinity ENIG 2.0

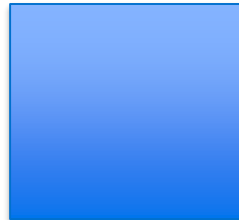
## Technical Service

### Your Technical Service Team



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*“Service is the key to satisfying our customers ”*

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