Affinity 2.0
Electroless Nickel – Immersion Gold
HIGH PERFORMANCE LOW VARIATION FINAL FINISH
Global Final Finish Team
April 2017
MacDermid Enthone Electronics Solutions
Leading Chemical Process Supplier in Global Electronics Markets
GLOBAL PRESENCE

[map showing locations with cities and countries labeled, including: Berlin, Germany; Lyon, France; Birmingham, UK; Seoul, Korea; Bangalore, India; Shenzhen, China; Singapore; Shanghai, China; Suzhou, China; Hangzhou, China; Beijing, China; Guangzhou, China; Dallas, TX; Shanghai, China; Shenzhen, China; Rome, Italy; Milan, Italy; Sao Paulo, Brazil; Londrina, Brazil; South Plainfield, NJ; Fremont, CA; Maple Plain, MN; Waterbury, CT; East Haven, CT; Chongqing, China; Wuhan, China; Kuching, Malaysia; Tokyo, Japan; Kanagawa, Japan; Beijing, China; Panyu, China; Labs, Tech Center; Global Center for Innovation; Global Development Applications Centers; Laboratories, R&D and Service Centers; Does not include sales offices, warehouses, and manufacturing facilities.]
Our Product Offerings

ADVANCED ELECTRONICS
- Damascene Copper
- Wafer Level Packaging
  - Bump Plating
  - Copper Pillars
  - Redistribution Layers

METALLIZATION
- Direct Metallization
  - Rigid PCBs
  - Flex Circuitry
- Electroless Copper
- Electrolytic Copper
  - High Throw DC
  - Periodic Pulse Reverse
  - Via Fill / Through Hole Fill

FINAL FINISHES
- Organic Solderability Preservative
- Immersion Tin
- Immersion Silver
- ENEPIG
- ENIG

MEMORY DISK
- Preclean and Zincate Solutions for AI substrate
- High Quality EN
  - High Corrosion Resistance
  - Low Particle Inclusion (PDI)
  - Low Pit Count

ELECTRONICS MATERIALS
- Leadframe Adhesion Promotion
- Component Termination Solderability
- Molded Interconnect Devices
- Light Emitting Diodes
- Solar Cell Metallization

ELECTRONICS SPECIALTIES
- Specialty Treatments for Copper
- Dryfilm
- Copper Etchant
- Resist Strippers
- Solder Strippers
- Connector Finishing
- Oxide and Oxide Alternatives
  - High RF Applications
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  - Affinity ENIG 2.0

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ENIG Popularity
Strength and Weakness Analysis

Advantages……

• Long Shelf Life
• No Tarnish
• No Whiskers
• Consistent Solderability (multiple refows).
• Aluminum Wirebondable.
• Surface Contact (Keypads)
• High Solderspread
• No Issues with Paste Misprints

Disadvantages……

• More Expensive (CEM/OEM)
• High Temperature Process (PCB Fab)
• Complex Process (PCB Fab)
• Not Re-workable (PCB Fab)
• Ni-Sn Solderjoint (Cu-Sn is preferred)
• Blackpad “Hangover” from the 90’s
Affinity ENIG 2.0
Reduced Variation - Higher Yield – Lower Operating Cost ENIG

- **Affinity ENIG 2.0** has been developed from the lead ENIG technologies from our newly integrated companies combining new innovations from our collective expertise.

- **EN Corrosion**
  - EN corrosion has been engineered out of the process eliminating concern and discussion with end users and OEM’s.

- **Six Sigma Development**
  - Defects and wastes driven out during development and process variation minimized in production—giving increased uniformity of product, compliance to OEM and End User specifications and unrivaled reliability.

- **The Lowest Gold Metal Operating Cost**
  - Low gold thickness variation over time and between feature sizes provides excellent control of gold consumption and significant opportunity for operating cost reduction.
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?

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

- Used to compare ENIG chemistries during development process.
- Created a focus to improve EN %P control and corrosion.
- Created a focus to eliminate cost.

Measurement System Analysis

- Used to understand Au thickness and EN%P measurement errors.
- Improved measurement of gold thickness and EN %P.
- Improved control of gold thickness and cost.

Statistical Process Control

- Used to ensure “Critical to Quality” process variables are under control.
- Same product every shift and every day.
Affinity ENIG 2.0
Technology Benefits – Six Sigma Development

Design of Experiments

- Used to optimize and understand effect and Interactions of Key Process Variables.
  - Issues engineered out during design stage.
  - MacDermid-Enthone service team has a deep understanding of the process.

Capability Analysis

- Used to assess process performance against End User or OEM specifications.
  - OEM specifications met.

Reliability Simulations

- Weibull and other reliability simulations undertaken to ensure deposit meets Industry expectations.
  - Reliability confidence when PCB’s are out in the field.
Affinity ENIG 2.0
Process Cycle and Equipment

Equipment And Plating Cycle:

- Affinity 2.0 fits into standard ENIG process equipment, giving technical benefits over incumbent processes.

- Equipment improvements available to deliver improved deposit distribution uniformity for new build or retro fit.

- Affinity Nickel 2.0 delivers 0.15-0.23 µ/min plating rate over 5 MTO giving unrivaled productivity.

- Affinity 2.0 has been engineered to be simple to use eliminating the need for complicated auto-control / analysis systems reducing engineering time and chance of operator error.
Affinity ENIG 2.0
Process Chemistry Overview

- **Acid Cleaner**
  - Options to take care of NPTH plating and produce chemically clean surfaces for subsequent processing.

- **Microetch**
  - Etch options to minimize variation of incoming copper surface.

- **Activator Pre-dip**
  - Helps minimize occurrence of galvanic skipping.

- **Palladium Sulfate Based Activator**
  - Low palladium concentration to minimize operating cost and formulated to eliminate extraneous and skip plating.

- **Activator Post-dip**
  - Helps to minimize risk of extraneous plating.

- **Electroless Nickel**
  - Dummy free, stable and easy to use chemistry. Provides superior phosphorous control, cosmetic appearance and deposit uniformity.

- **Immersion Gold**
  - Optimized for low gold metal operation with excellent thickness and corrosion control.
A Platform Specialty Products Company.

AFFINITY ENIG 2.0
Pre-Treatment
Affinity ENIG 2.0
Pre-Treatment Technology Overview

There are many variables in the PCB manufacturing process prior to the ENIG process that can effect yield. Affinity 2.0 has been developed with pretreatment options designed to minimize variation in incoming panel quality.

- **Affinity NPTH Cleaner 2.0**
  - Excellent cleaning of copper surfaces removing dirt, oils, and copper oxidation ensuring nickel adhesion and coverage.
  - Ties up residual palladium in tooling holes from electroless copper processing preventing undesired plating.

- **Affinity Etch One**
  - Produces cleaned etched surface for optimal palladium adsorption.
  - Modifies copper topography to provide uniform low roughness surface for Electroless Nickel grain formation eliminating larger EN grain boundaries which are more prone to galvanic attack in Immersion Gold chemistry.

- **Affinity Activate PDS**
  - Optimized to activate copper surfaces and eliminate extraneous plating on a variety of commonly used and high performance PCB laminates.
  - Mild formulation minimizes copper build up and provides long solution life giving high performance with economical operating cost.
Affinity ENIG 2.0
Cleaner Technology

Affinity Cleaner 1.0

• **Affinity Cleaner 1.0** and **Affinity NPTH Cleaner 2.0 both** provide effective removal of copper oxide, fingerprints and other soils from previous manufacturing processes.

Affinity NPTH Cleaner 2.0

• **Affinity NPTH Cleaner 2.0** is a two part cleaning system that provides a solution for elimination of unwanted plating in tooling holes. Utilization of a palladium poison renders residual palladium inactive during the cleaning process preventing Electroless Nickel plating.
Affinity ENIG 2.0
Microetch Technology

• Excessive copper roughening prior to soldermask application can result in irregular grain boundary formation during Electroless Nickel deposition. Irregular EN grain boundaries have been cited as potential sites for excessive corrosion during Immersion Gold deposition.

• **Affinity Etch and Affinity Etch One** microetch processes contain surface topography modifiers which allow reduction of surface roughness creating uniform copper surfaces and resulting in a more uniform Electroless Nickel surface.
Affinity ENIG 2.0
Microetch Post-Dip Technology

- Trapped microetch chemistry in partially plugged via holes can create galvanic cells with enough potential to prevent Electroless Nickel plating along the connected trace.

- Use of a simple sulphuric acid post dip following microetch is sufficient to assist with removal of the trapped process chemistry.

- MacDermid-Enthone recommend inclusion of this process step to safeguard against galvanic skipping pads without resorting to expensive proprietary chemistry.
Affinity ENIG 2.0
Activator Technology

- **Affinity Activate PDS** is a palladium sulphate based activator optimized for compatibility with common and advanced substrates alike.

- Skip and extraneous free electroless nickel deposition ensuring yield maximization.

- Operation at 25 ppm of palladium giving low make cost and drag out losses.

- Mild corrosivity for copper ensures long working bath.

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**FR-4 Material**

**Aluminum Nitride Ceramic**

**Isola P96**

**Arlon 85N**

**Rogers 3010**
Affinity ENIG 2.0
Activator Post-Dip Technology

• Post Dip Chemistry has the ability to removal residual palladium from tight geometries and hold in solution preventing re-deposition.

• This results in cleaner feature edges and a reduction in extraneous plating with problematic spacing and or materials.
AFFINITY ENIG 2.0
Electroless Nickel
Affinity ENIG 2.0
Electroless Nickel Technology Overview

Affinity 2.0 Electroless Nickel has been designed to work synergistically with the Affinity 2.0 Pre-Treatment chemistry to ensure a uniform and consistent initiation of electroless nickel. **So what does this mean to the PCB Fabricator?**

Affinity 2.0 Electroless Nickel’s enhanced chemistry delivers……

- **“Right first basket” start up.**
  - Reduced cycle time and cost by elimination of need to dummy plate.
  - **Efficient even in stop/start situations. No need to worry about start up procedures**

- **Consistent basket to basket nickel thickness.**
  - Consistent productivity irrespective of Electroless Nickel solution age.
  - **Formulation minimizes effect of EN property changes as bath ages = consistent rack to rack deposition.**

- **Superior control over phosphorous content over long Electroless Nickel life.**
  - **Improved cosmetic appearance of ENIG deposit.**
  - **Consistent corrosion resistance of Electroless Nickel deposit.**
    - **Consistent gold thickness basket to basket.**

- **Simplified operation.**
  - Elimination of operator intervention.
  - **Reduced special cause variation and potential for operator error.**
Affinity ENIG 2.0
Technology Benefits – Electroless Nickel Plating Rate

Having high and consistent plating rates allows the PCB fabricator high levels of productivity and increased control over EN thickness without having to adjust Electroless Nickel pH to maintain throughput and the resultant phosphorous content sacrifices.

- Temperature increase from 80 to 86 °C allows consistent electroless nickel thickness to be achieved over 5 EN MTO’s.
  - Consistent EN thickness with increasing EN age.
  - All EN cells have same plating speed.
  - No reduction in productivity.

- Temperature adjustment has no significant effect on the electroless nickel phosphorous content, and is thus preferred to pH adjustment.
Neither EDS or XRF showed good %P analysis performance (< 10 % of the tolerance).

The XRF method showed minimal bias (error reading the standard) and if enough measurements are made the average %P is close to the actual.

It was determined that averaging 10 XRF measurements provide a suitable measurement system of EN %P.
Affinity ENIG 2.0
Technology Benefits – Electroless Nickel Phosphorous Content

- Some traditional EN systems utilize pH adjustment to maintain plating rate with age, thus reducing the EN %P.
- Affinity 2.0 EN uses temperature increase to maintain plating rate and thus no effect on the deposit %P content.

- Thus Affinity 2.0 EN maintain consistent deposit properties over the working life of the chemistry.
  - With high MSE associated for EN %P this reduces chance of EOL deposits being out of specification.
Predictable EN deposit %P allows...

- High conformance to OEM and end user specifications.
- Consistent corrosion resistance.
- Excellent gold thickness control.
- Consistent low level of observed corrosion anomalies.
- Consistently reliable functional performance.
Affinity ENIG 2.0
Technology Benefits – Consistent EN and ENIG Structure

- Affinity 2.0 provides a consistent and uniform EN deposit structure over 5 MTO's. This allows not only consistent gold deposit but improved cosmetic appearance.
Affinity ENIG 2.0
Technology Benefits – Consistent Cosmetic Appearance

- Affinity 2.0 Electroless Nickel’s highly uniform structure allows improvement in ENIG cosmetic appearance.
- Improved “haloing” of PTH-in-ground features.
- Reduced pad-pad color differences between adjacent pads connected to trace or ground area.
AFFINITY ENIG 2.0
Immersion Gold
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.

**Anodic Reaction**
Ni $\rightarrow$ Ni$^{2+}$ + 2e$^-$

**Cathodic Reaction**
2[Au(CN)$_2$]$^-$ $\rightarrow$ 2Au$^+$ + 4CN$^-$
2Au$^+$ + 2 e$^-$ $\rightarrow$ 2 Au

**Overall Reaction**
Ni + 2[Au(CN)$_2$]$^-$ $\rightarrow$ 2Au + [Ni(CN)$_4$]$^{2-}$
IPC4552A section "3.6 Nickel Hyper-Corrosion" discusses and tries to add some sense and uniformity to the ongoing ENIG corrosion acceptability and reliability argument.

Key Points....

- Some occurrences of hyper-corrosion will always be found if enough samples are taken from a printed board or if excessive magnification is used for evaluation. A single occurrence of hyper-corrosion is NOT rejectable.

- The defect associated with hyper-corrosion is non-wetting (although the gold has been consumed) as defined by a lack of Intermetallic Compound (IMC) formation.

- **Hyper-corrosion may be evident but** if it does not interfere with the formation of a reliable solder joint as defined by contiguous IMC formation, it is **NOT considered to be rejectable.**

- **Severe hyper-corrosion whereby the soldering is impacted negatively is a rejectable condition.** Inspection of hyper-corrosion for acceptance criteria **shall** use optical microscopy at a maximum of 1000X magnification.
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Non-wetting soldering defects can occur for many reasons. For this reason a consistent and low level of EN corrosion is advisable to avoid any solderability failure being diagnosed as “Hyper Corrosion”.
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.

Gold Deposit
Corrosion Spikes
Electroless Nickel
Copper

Electroless Nickel
Copper

O₂
O₂
O₂

Au⁺
Ni²⁺
Ni²⁺
Ni²⁺
O₂
O₂
O₂

Ni²⁺
Ni²⁺
Ni²⁺
Ni²⁺
O₂
O₂
O₂

Traditional ENIG
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.

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
Technology Benefits – Corrosion Control

- 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
Gold Thickness Control: Ability to meet Specification

Table 3-1 Requirements of Electroless Nickel Immersion Gold Plating

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

Revision A to IPC4552.

$\bar{X} - 3s \geq 0.04 \mu m \geq 1.58 \mu In$

$\bar{X} + 3s \leq 0.1 \mu m \leq 3.94 \mu In$

- 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 is good deposit distributions can be achieved.
  - This offers potential savings in gold metal consumption.
Affinity ENIG 2.0
Gold Thickness – IPC4552 Rev A Specification

- Gold thickness specification statistical constraints adds more pressure to maintain a consistent gold thickness.
- Affinity ENIG 2.0 shows consistent basket to basket gold thickness control - no thickness variation due to EN age.
- High level of conformance to the IPC4552 (Revision A) specification - 0 DMPO (no out of specification parts produced).
Affinity ENIG 2.0
Gold Thickness – IPC4552 Rev A Specification

- Gold thickness specification statistical constraints adds more pressure to maintain a consistent gold thickness.

- Affinity ENIG 2.0 shows consistent basket to basket gold thickness control - no thickness variation due to EN age.

- High level of conformance to the IPC4552 (Revision A) specification - 0 DMPO (no out of specification parts produced).

- Potential for reduction in gold consumption - Average gold thickness reduction.
Affinity ENIG 2.0
Understanding Variation: What Does Gold Distribution Mean For Quality and Savings?

- A normal distribution will have 99.7% of all data evenly distributed ± 3 standard deviations from the population mean ($\mu$).

- Therefore 99.85% of all gold thickness measurements will be + 6 standard deviations from the minimum thickness measured.
Affinity ENIG 2.0
Understanding Variation: What Does Gold Distribution Mean For Savings?

- Some PCB fabricators only care about not exceeding the minimum specification gold thickness.
- With poorly distributed Immersion Gold thickness this can lead to significant waste.
Affinity ENIG 2.0
Understanding Variation: What Does Gold Distribution Mean For Savings?

- Some PCB fabricators only care about not exceeding the minimum specification gold thickness.
- With poorly distributed Immersion Gold thickness this can lead to significant waste.
- Affinity ENIG 2.0 has been demonstrated to deliver significantly improved gold thickness distribution over 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
Technology Benefits – Basket to Basket and Within Panel Gold Thickness Comparison

• Affinity 2.0 – Shows a consistent average thickness over time (5 EN MTO’s) due to minimized basket-basket gold variation. Affinity 2.0 also shows superior gold thickness dispersion around the average gold thickness due to the superior within panel distribution. These two features provide excellent control over gold thickness and therefore cost.

• Affinity 2.0 and three competitive ENIG systems were analyzed for basket to basket gold thickness as well as within panel gold thickness.
  - 4 different pad sizes
  - 5 Panel locations
  - Over 5 EN MTO’s
Affinity ENIG 2.0
Technology Benefits – Proving Cost Savings

- Affinity ENIG 2.0 deposits have shown consistent low gold distribution vs competitive products in benchmarking exercises.
- Affinity ENIG 2.0 has potential to realize large reductions in gold metal consumption.
## Affinity ENIG 2.0

Technology Benefits – Average Gold Thickness Reduction / Cost Saving Calculation

<table>
<thead>
<tr>
<th></th>
<th>Incumbent</th>
<th>Affinity 2.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Gold Thickness</td>
<td>1.60</td>
<td>1.00</td>
</tr>
<tr>
<td>Gold Thickness Standard Deviation</td>
<td>0.2500</td>
<td>0.1500</td>
</tr>
<tr>
<td>Average Au Thickness</td>
<td>2.35</td>
<td>2.05</td>
</tr>
<tr>
<td>Gold Metal Consumed</td>
<td>0.0316</td>
<td>0.0276</td>
</tr>
<tr>
<td>Gold Metal Cost</td>
<td>$1.20</td>
<td>$1.044</td>
</tr>
<tr>
<td><strong>Gold Consumption Reduction</strong></td>
<td><strong>12.77%</strong></td>
<td></td>
</tr>
</tbody>
</table>

### Gold Consumption Reduction

- **Product Estimate Month**: 125,000
- **Monthly Saving**: $19,106.50
- **Annual Saving**: $229,278.06

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**Gold Thickness Distribution**

**Affinity 2.0 ENIG vs. Competitive System**

- **Au Metal $/g**: 37.85
- **Metal Area**: 15.00%

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A Platform Specialty Products Company.
AFFINITY ENIG 2.0
Reliability and Performance Testing
Affinity ENIG 2.0
Lead Free Soldering – Introduction

- Affinity ENIG 2.0 Supercoupons TV’s processed at every EN MTO.
- All samples for Lead Free solderability testing were pre-conditioned by processing X3 as per the attached lead free profile.
- Following Pre-Conditioning these TV’s were assessed for solderspread and ballshear using as well as PTH fill by lead free wave soldering.
- Peak Temp of Panel = 255 °C
Affinity ENIG 2.0
Technology Benefits – Soldering

- Using **Alpha CVP-390 SAC305** solderpaste, Affinity 2.0 shows excellent solder wetting properties following X3 lead free reflow.

- Solderspread analysis shows high and consistent % spread measurements from 0 – 5 EN MTO’s.
Affinity ENIG 2.0
Technology Benefits – Soldering

- Affinity 2.0 shows excellent high and consistent ball shear performance.
- All failures observed are the preferred ductile failure mode (within solderball).

**Boxplot of Affinity 2.0 Ball-Shear vs EN MTO**

![Boxplot of Affinity 2.0 Ball-Shear vs EN MTO](image)

- 1. Pad/Substrate
- 2. Intermetallic(IMC)
- 3. Solder Joint
- 4. Bulk Solder

**Laminate**

**Solder Ball**

0 MTO 1 MTO 2 MTO 3 MTO 4 MTO 5 MTO
Affinity ENIG 2.0
Technology Benefits – Soldering

• Supercoupons TV’s were evaluated for PTH filling by passing through Novastar solderwave equipment under standard conditions for SAC alloy using Alpha EF6000 Flux.

• % of PTH’s filled to Target conditions of **IPC J-Std 003** was calculated.
Affinity ENIG 2.0
Technology Benefits – Soldering

- Affinity 2.0 shows excellent high and consistent PTH filling following X3 lead free reflow - easily conforming to IPC J-Std 003.
Affinity ENIG 2.0
Value Proposition Statement

- Significant operational savings from superior within panel gold thickness distribution and basket to basket thickness control versus competitive processes.

- Low and consistent corrosion eliminating discussion and concern over reliability.

- Six Sigma approach to R&D and process control provide robust manufacturing, increased yield and conformance to end user specifications.

- Process simplicity results in reductions in labor costs, engineering input, defects and production strain.
MacDermid-Enthone propose to process standard test vehicles through incumbent ENIG process over the course of the EN life (beginning, middle and end as a minimum).

MacDermid-Enthone will analyze the gold thickness distribution, examine the corrosion as well as other key attributes of the ENIG process and provide a report detailing the operating cost reduction and technical benefits in switching to Affinity 2.0.

MacDermid-Enthone will process any additional test vehicles required by the customer through Affinity ENIG 2.0 and return them for evaluation.
For more information…

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