



ENIG

Electroless Nickel / Immersion Gold
The Process

NHW / ENIG November 2011



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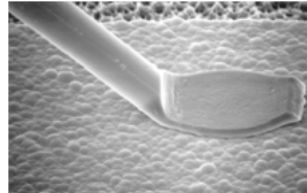
ENIG – Main Industrial Requirements

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Main Industry Requirements ENIG

- ▶ Multiple Soldering Capability (Sn-Pb & Pb-free)
- ▶ Aluminium Wire Bondability
- ▶ High and Constant Contact Resistance for keypads and switches
- ▶ Planarity
- ▶ P-content range 7 – 10 %
- ▶ Shelf life of 12 months



Al-wire bonding (25 µm AlSi 1%) on ENIG

ENIG finish preferably used for high end application

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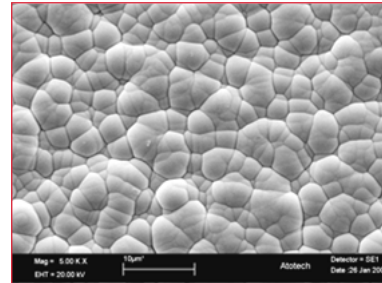
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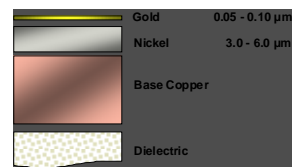
ENIG - OVERVIEW

ENIG- overview

- ▶ A dual metal deposition process
- ▶ Ni-P functions as diffusion barrier
- ▶ Ni-P also adds strengths to plated through holes and vias
- ▶ Au is dissolved into solder
- ▶ Forms nickel-tin IMC
- ▶ Thin Au-layer minimizes interaction of Ni with environment
- ▶ Well established process (since early nineties)



Top view of an ENIG layer



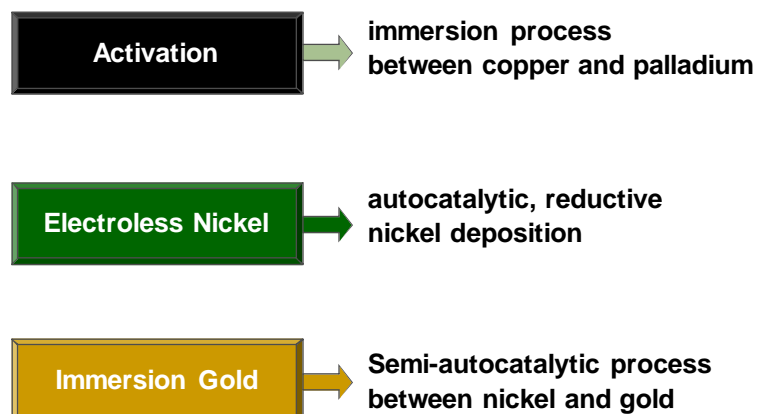
ENIG is a highly versatile surface finish

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ENIG- Overview

Reaction Mechanism

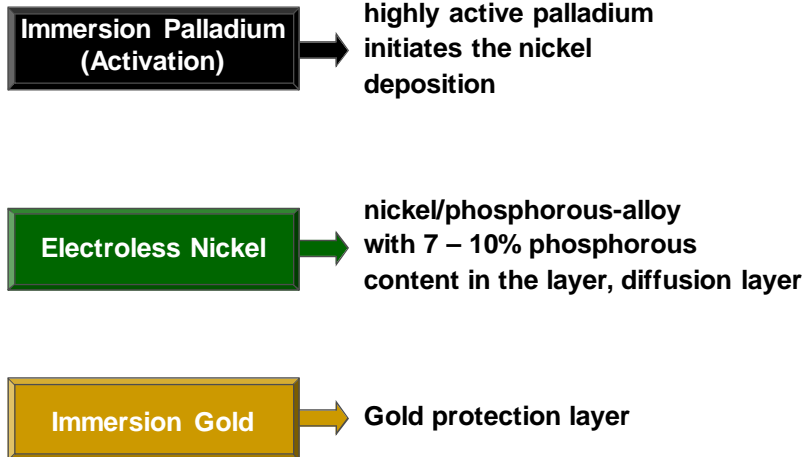


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ENIG- Overview

Function of Deposit



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ENIG – PROCESS SEQUENCE



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ENIG Process Function

Acid Cleaner –

- Removes oxides, soils, and developer residues after solder mask application and curing.
- Deoxidizes the copper surface
- Wetting of holes and surface
- Preparation of the copper surface for a smooth attack of the micro etch



Cleaner Micro Etch Pre Dip Activator E'less Nickel Imm. Gold

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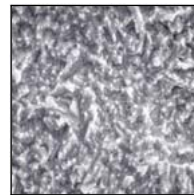


ATOTECH

ENIG Process Function

Micro Etch –

- Chemical and mechanical Cleaning of copper surface
- Deoxidizes the copper surface
- Micro roughening and enhancing of the surface area for best activation
- Removal of low residual soldermask contamination



Cleaner **Micro Etch** Pre Dip Activator E'less Nickel Imm. Gold

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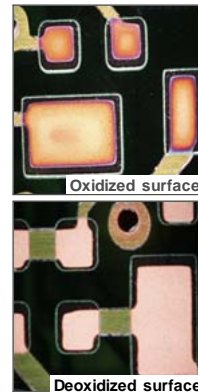


ATOTECH

ENIG Process Function

Pre Dip –

- Deoxidizes the highly active copper surface after micro etch
- Prevents Palladium hydrolysis
- Protects the activator
- Ensures constant acid content in the activator



Cleaner Micro Etch **Pre Dip** Activator E'less Nickel Imm. Gold

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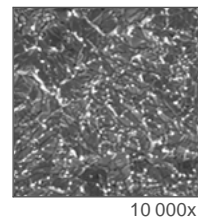


ATOTECH

ENIG Process Function

Activator –

- Sulphuric acid based Palladium activator
- Generates a Pd-monolayer on the copper surface.
- Ensures a uniform Ni-deposition start and an even nickel deposition



Cleaner Micro Etch Pre Dip **Activator** E'less Nickel Imm. Gold

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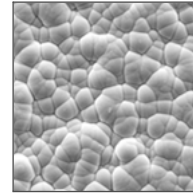


ATOTECH

ENIG Process Function

Electroless Nickel

- Deposits a mid range NiP-alloy (7 – 10% P)
- Deposit Thickness 4.0 – 6.0 microns
- Constant plating speed and constant P-content during lifetime
- By Atotech developed control devices ensuring longest bath life time 6 MTO
(6 x 6 g/l = 36 g/l Ni)
 - Nickel Controller / bath components
 - Protektostat / stainless steel parts
 - Online Controller / stabilizer control



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• Creates a solder- and bondable NiP-layer

Cleaner Micro Etch Pre Dip Activator **E'less Nickel** Imm. Gold

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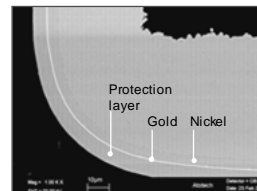
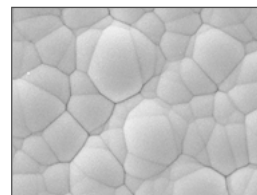


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ENIG Process Function

Imm. Gold –

- Deposits a dense pure gold layer over nickel
- Deposit Thickness 0.07 – 0.12 Microns
- Prevents nickel from oxidation
- Ensures a fast wetting during soldering processes
- Ensures storage for 12 month
- Has longest bath life time 6 MTO
(6 x 2 g/l = 12 g/l Gold)



Cleaner Micro Etch Pre Dip Activator E'less Nickel **Imm. Gold**

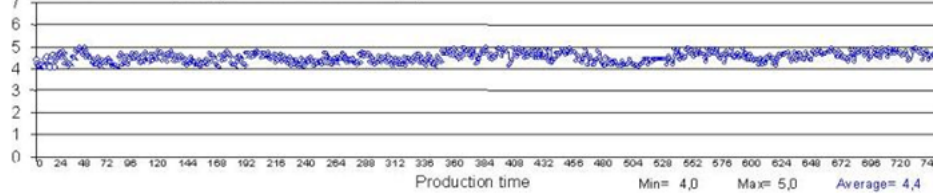
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Consistent nickel thickness over bath life

Time frame 31 Days production / 2400 panels a day

Nickel Thickness [μm] (total 10 bath make ups)



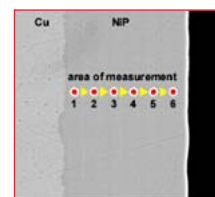
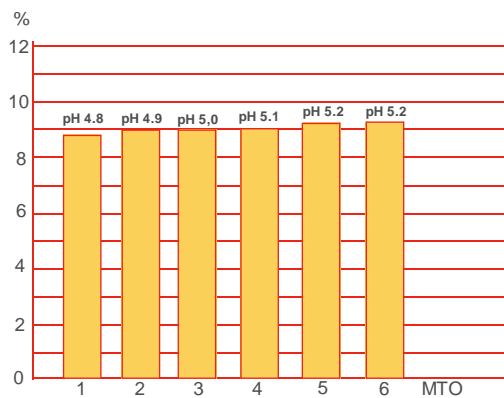
Consistent nickel thickness provides consistent P-content

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Results

Consistent P-content range over bath life



Fluctuation of P-content within layer

Position of measurement [μm]	P-content [wt.%]
1	9.2
2	9.1
3	9.0
4	8.3
5	8.5
6	8.6
mean value	8.8
stand. dev.	0.33

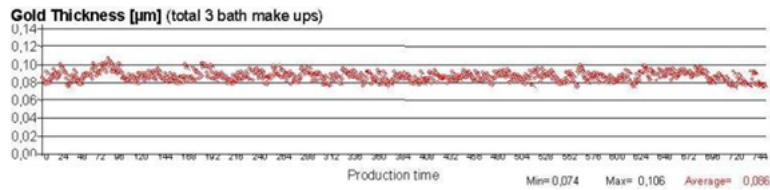
Consistent P-content provides consistent layer quality

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Consistent gold thickness over bath life

Time frame 31 Days production / 2400 panels a day



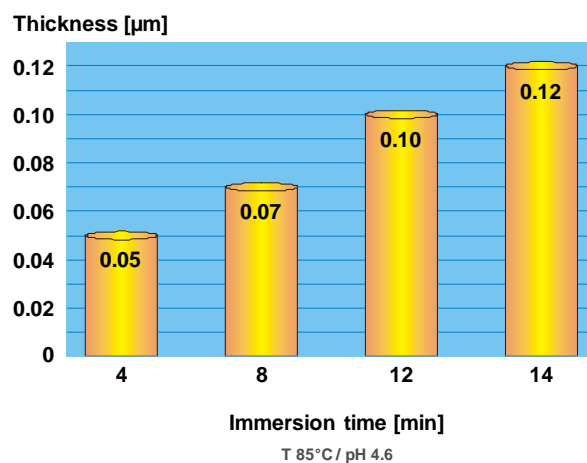
Consistent gold thickness provides nickel protection with minimized corrosion

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Immersion Gold

Gold Thickness Relative to Immersion Time



Consistent gold thickness provides nickel protection with minimized corrosion

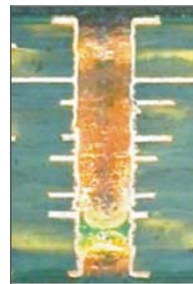
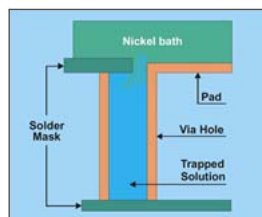
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ENIG – Optional process steps

ENIG Optional Step: Aurodip

Ensuring proper rinsing of entrapped chemistry in partially plugged holes

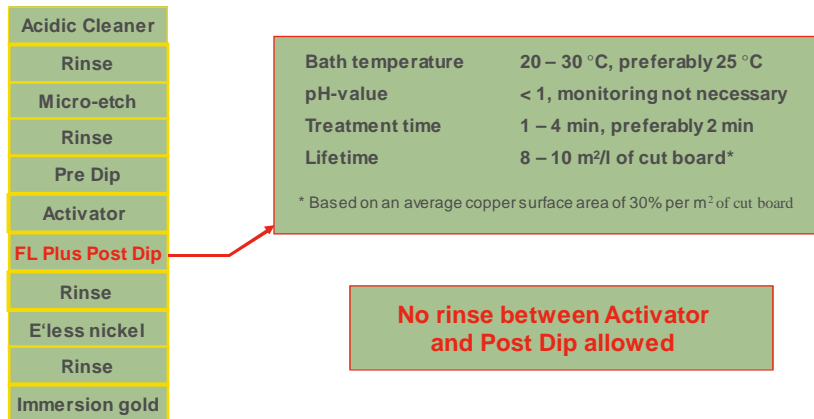


By accident / on purpose

Option

Cleaner Micro Etch **Pre Dip** Activator E'less Nickel Imm. Gold

ENIG Process flow including FL Plus Post Dip

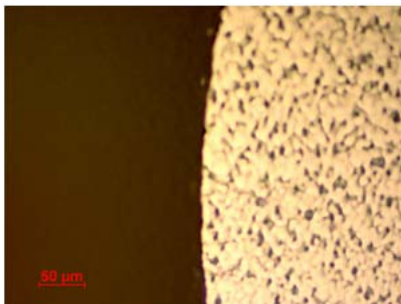


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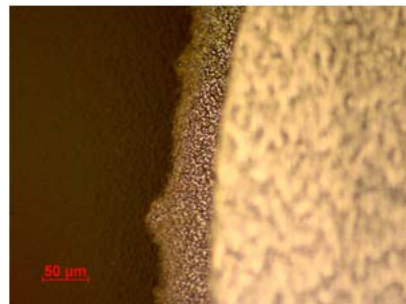
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Application of FL Plus Post Dip

With FL Plus Post dip



Without FL Plus Post dip



Both samples were excessively immersed in the activator (5 min.) and plated in a highly active nickel bath

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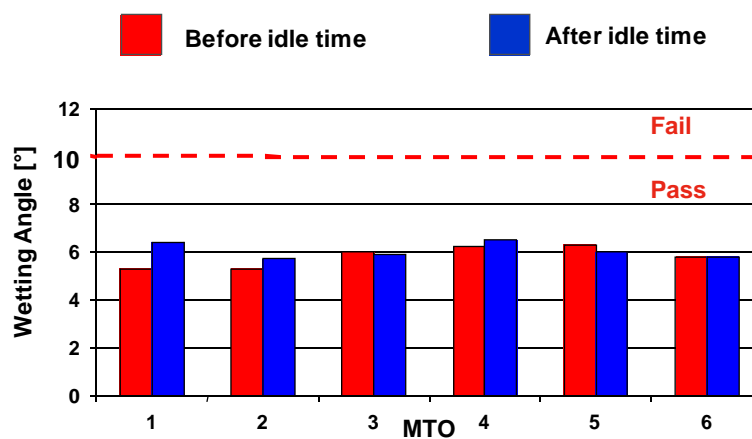
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ENIG - Process Performance

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ENIG Process Performance Wettability - Solder Spread / Idle Time



*Wettability independent of MTO / Idle Time**

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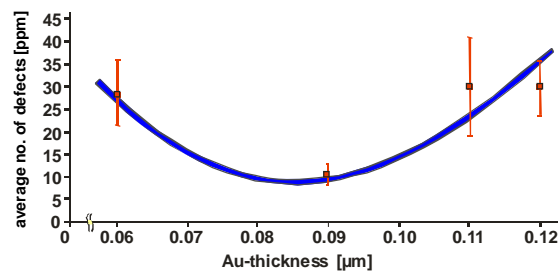


ATOTECH

ENIG – process performance

Impact of Gold thickness – Soldering Performance

Multisoldering aged 1 x rf, wave soldering (without components)
Flux ultrasonic assisted flux - Alpha Grillo NR 100 (1.8% solid)
Target solder rise above 75% (2.4mm / 1.2mm hole)



Optimum wettability between 0.07μm to 0.1μm Gold
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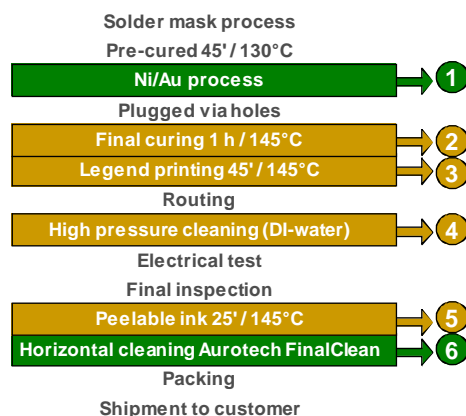
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Impact of Cleanliness – Soldering Performance



Influences on solderability after ENIG plating
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ENIG Impact of Cleanliness – Soldering Performance

ENIG - Aureotech

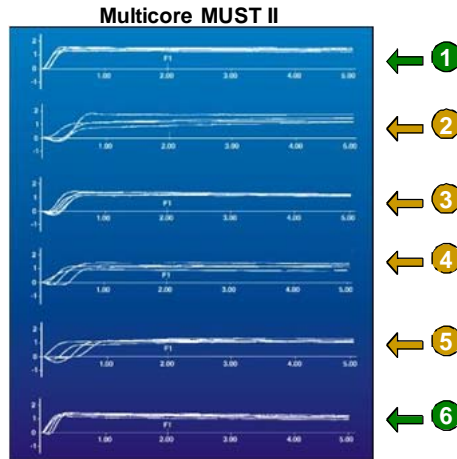
Final curing

Legend printing

High pressure cleaning

Peelable ink

Aureotech FinalClean



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Final cleaning ensures/ recovers perfect solderability
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ENIG - SUMMARY

ENIG – Summary

Concerns & limitations

- – Cost of precious metal
- – Potential brittleness of nickel-tin IMC (if no copper in solder joint)
- – Corrosion of nickel by immersion gold solution
- – Process operating window; requires tight control
- – Not suitable for gold wire bonding applications
- – High level of maintenance

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ENIG – Summary

Benefits

- ✓+ Suitable for multiple Pb-free soldering (even air atmosphere)
- ✓+ Planarity for surface mount device applications
- ✓+ Barrier layer (nickel) to stop dissolution of copper
- ✓+ Good shelf life (>12 months)
- ✓+ Good surface for ICT probability
- ✓+ Suitable for contact switching applications
- ✓+ Good resistance in corrosive environments
- ✓+ Suitable for aluminum wire bonding applications
- ✓+ Suitable for high aspect ratio through holes

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