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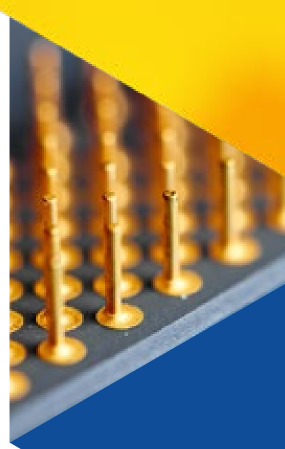
CLEARSignals

World Leader in Memory Solutions Leads OEM Move to UIC ENEPIG

Micron Technology is a leader in innovative memory solutions and a company instrumental to the world's most significant technology advancements. Its Systems Integration Group ("SIG") in Boise, Idaho, produces custom switch gears and ATEs (automated test equipment) for screening semiconductor memory devices.



PCBs used in these applications must be solderable, and able to survive repeated probe touch-down conditions at a low interface resistance, and over a range of surface stresses. Complicating these scenarios are extreme temperatures, variable humidity, and organic vapor formation. Specifying the most reliable final finish for these applications is paramount to product success.

Micron's PCB fabrication process uses light force spring pins – those with contact forces less than 15-10 gm. These hydrostatic pressure connections hold electrical components in place by virtue of the pressure of the pin against the ENIG pad and are a godsend for complex board assemblies. In event of malfunction, it's the component, not the $20K board, that's replaced.

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Its reduction-assisted reaction allows you to autocatalytically keep depositing gold ions.”

The downside of contact bonding is the potential for pin-to-pad contact failure. ENIG and ENEPIG have both been susceptible to contact resistance-initiated failures. Most often, the cause had been migration and oxide formation initiating from the gold to nickel or gold to palladium-nickel layer. These layers both use corrosion or replacement gold reactions for metal deposition, which until now has been the only viable option.

Uyemura recently introduced a reduction-assisted gold reaction process for ENEPIG called TWX-40. It is distinctive in that the gold is deposited primarily by an autocatalytic (electroless) reaction. The reaction produces a thicker, lower porosity gold deposit that minimizes palladium’s exposure to the environment.

And while electroless gold baths have historically been difficult to control, UIC’s new TWX-40 hybrid process maintains exceptionally high stability for both of its two simultaneous reactions. This new electrolyte is a game-changer for OEMs seeking a high reliability final finish.

Dan Cram, Mechanical Engineering Manager for Micron’s Systems Integration Group, explains the issues, and Micron’s solution:

> *“Historically, ENEPIG boards manufactured for Micron had passed initial electrical testing, then manifested gross failures in advanced test environments. The culprit was hypercorrosion of the electroless nickel layer caused by extended gold immersion times required by conventional ENEPIG processing.*
>
> *“As device pitches, scale and I-O counts shrink, so too do the interface schemes – the test technology – the board size, scale and pitch, to pace with packaging designs. This has driven the need to reduce contact technology - whether spring probe, membrane style contact or soft-touch spring metallic interface system – as well, both in size, and in force.*
>
> *“The contacts provide the spring action to compensate for irregularities in the solder ball interface, and the lead frame material or device you’re using,” he explains. “The latter is typically a tin-coated lead frame or solder ball structure which has some coplanarity variation. So there will be some contacting (spring) assembly acting as an electrical pathway to the opposing circuit board assembly.*
>
> *“As force goes down, you need to keep the stress high enough to break through the oxides and surface film in order to achieve the lowest possible interface resistance. If interface resistance rises, it will degrade amplitude, and compress the eye height. It will also create an RC function – a time constant - where it delays the signal, causing the eye to either shrink laterally or shift in time, both of which reduce signal quality. So, your margin for testing the parts, and screening them effectively, diminishes.”*

So the challenge is, as pitches go down, the forces involved have to be reduced because the unit area of the pitch and the contact interface have been reduced.

> *“Reduced pitch scale can result in probe forces dropping as low as 8 grams. This is such a light touch on the surface plating on the PCB pads that the ability to break through surface films such as oxides and organic vapors becomes questionable, and the ability to get a low ohmic interface is challenged.*
>
> *“Ultimately you want a noble, durable finish that provides an oxide-free environment, as well as a finish that will survive millions of cycles of pogo-sticking up and down on the pad without compromise.”*

So, making a uniform and reliable interface, in the presence of surface films, and in a potentially polluted environment, is the challenge.

> *"The PCB industry loves very thin plating due to the cost of gold. However, thin gold deposits are porous and easily worn away, exposing the underlying surface. If that surface is nickel, nickel readily oxidizes, and tends to migrate, and while the oxide is thin, it is hard and insulating, all of which contribute to failure."*

These surface metal issues produce a poor electrical response, and support the use of palladium, which provides both a hard underlying surface, and a nickel migration barrier. An appreciably thick gold deposit had always proved difficult and risky to obtain without damaging the underlying nickel, because a long dwell in an immersion gold electrolyte causes hypercorrosion of the underlying nickel layer.

> *"Sometimes problems only manifest in the end use environment, with the development of copper creep, cavities and plating rupture, and ultimately, electrical failure."*
>
> That's where Micron has established what Cram refers to as a 'safe' position. *"IPC specs are simply not adequate for our applications, because contacting with a very low energy surface probe, and soldering the rest of the PCB assembly are diametrically opposed requirements.*
>
> *"I could go with thick nickels, thick plating layers, and other overkill. I could also do heavy gold layers, but that would foul the solder joint, and result in embrittlement failure".*
>
> *"Also, because palladium is a catalytic metal, it reacts easily with organic vapors to create a stubborn insulating barrier layer. "This is not an oxide, but a palladium organo-complex film that sits on the mating surface. To prevent this, you need a thick layer of nonporous gold over the palladium, to provide a soft cushion to break surface films that deposit onto the surface."*

The "safe position" requires getting a thick enough plating layer of palladium and gold to protect the nickel and copper without enabling hypercorrosion from the immersion gold bath.

> *"This is where Uyemura's mixed reactant electrolyte, TWX-40, provided the solution. Its reduction-assisted reaction allows you to autocatalytically keep applying gold ions, facilitating faster gold build-up and shorter dwell times, without a corrosive replacement reaction. This autocatalytic deposition process provides a huge advantage over what the rest of the industry does."*
>
> Cram believes that hypercorrosion, and particularly its delayed effects, are not getting the attention they deserve. *"Because interface or contact failure occurs on less than ½ of 1% of available contacts, it's regarded as a 'background' problem – something with simple solutions, such as cleaning and re-seeding.*
>
> *"Some fails do have simple causes, such as contamination. But a larger percentage of small intermittent fails are caused by the selection of materials.*
>
> *"If you're not using probe forces beyond about 20-50 grams of force, you won't be able to penetrate it. the result will be intermittent behavior and resistant interfaces – which is exactly what we've seen.*

"In the world of interconnects, the failure tolerance for many applications is zero. You're only as good as the single failure that occurs every one in 10,000 - or 100,000."

Cram is currently working on high density probe cards: interface systems with potentially 30,000 to 60,000 individual contacts touching a large wafer or structure.

> *"Their tolerance for failure is absolutely zero; all of them have to work every time. Yet, failures remain possible because of quality issues related to the surface, or the selection of materials, whether you're using immersion or electrolytics, surface film, and the type of plating.*
>
> *"In these prolific 'lower probe force' applications, where demands are constantly changing, ENIG and ENEPIG initially looked like good solutions. However, experience has shown that you often see some black pad or hypercorrosion that manifests only when the product under an electrical potential is exposed to higher humidity and temperatures above 65˚C for extended periods. The ionic migration and accelerated metal layer diffusion that occur are common – and disastrous for contact interface reliability.*
>
> *"If the product is a TV or toaster and you're putting it together once, it's not an issue, because*

> *the original mating created a gas-tight interface. But if you have repeated mating and unmating, as is the case with ATE systems, it will ultimately be a problem – and a failure."*
>
> This is compounded by the fact that some applications call for the metallized surface to be soldered. *"You need a finish that's compatible with soldering, and with low energy contact systems.*
>
> *"There's an equation that works for just contacting – and one for soldering. What's needed is the 'Goldilocks' formula: plating sufficiently thick to prevent corrosion of the base surfaces during immersion, but not so thick that it causes problems with solderability and solder joint embrittlement."*

Micron Technology's SIG engineering team became familiar with Uyemura ENIG and ENEPIG processes in 2015.

> *"We investigated Uyemura and several of its competitors to determine where their advantages were, and how we could get good target values," recalls Cram.*
>
> *"If the PCB fabricator simply does what's specified on the print, they can hit their target, but still risk both corrosion and hypercorrosion. We needed to be experts at all aspects of the fabrication process, and, equally important, the limitations of various immersion processes."*

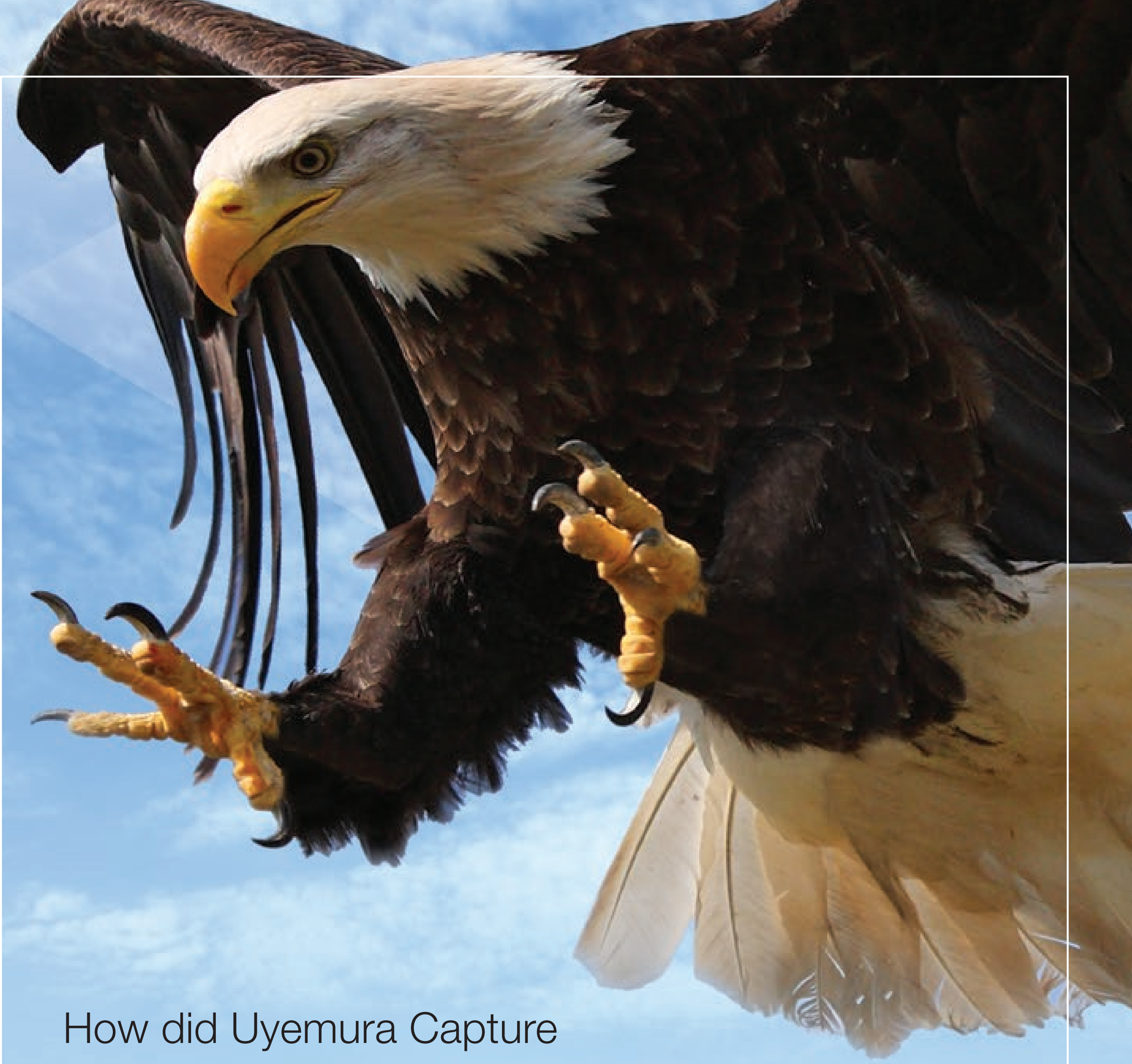
Early on, the market promoted the idea that ENEPIG was immune to black pad – what people refer to as nickel attack or crevice corrosion through the grain boundaries of the nickel, which ultimately attacks the copper.

> *"ENEPIG may not be as prone to black pad, but it is certainly vulnerable to corrosion if the gold plating is too thick or if the immersion time is too long. It will find a way through the foot where it meets the PCB and attack the copper through the nickel, creating latent black pad. You see it when you solder it: in voids, dewetting and other problems."*

Micron tested the ENIG/ENEPIG chemistries of three leading suppliers, selecting the Uyemura processes. These advanced processes use Uyemura's Talon electroless palladium and TWX-40 reduction-assisted thick gold. The process develops a thicker, lower porosity and exceptionally uniform gold deposit.

The final deposit was developed specifically for use over electroless palladium and is virtually corrosion-free.

Uyemura ENEPIG has been specified on Micron's newest designs. It represents an important advancement in product reliability for Micron's ATE product line.



How did Uyemura Capture the Market for ENEPIG?

It was our **Talon Electroless / Alloyed Palladium Phos**

Talon is the most cost-effective palladium process available for ENEPIG. Designed for economy, it is also the most stable and versatile electroless palladium platform in use today.

Talon deposits palladium directly onto copper, also aluminum and electroless nickel. It is solderable and gold wire-bondable, and provides a consistent deposition rate and deposit quality throughout the life of the bath.

Talon is now the leading electroless palladium for ENEPIG.

New from Uyemura

ENEPIG "2.0"

ENEPIG has (at last!) reached its ultimate performance potential!

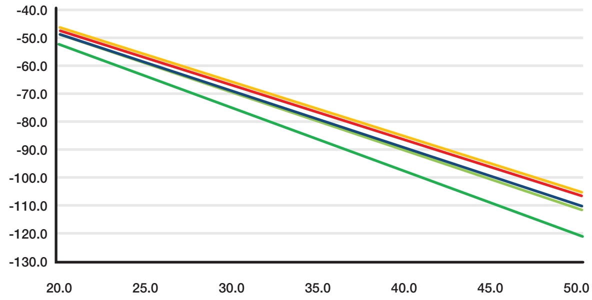
With its uniquely flexible and stable electrolytes, plus Talon electroless/alloyed palladium phos, the next-gen in ENEPIG performance is now available.

- Lowest make-up and operating costs
- Pure palladium formulation available
- Reduction-assisted TWX-40 plates up to 8µin of gold, eliminates corrosion and deposit porosity

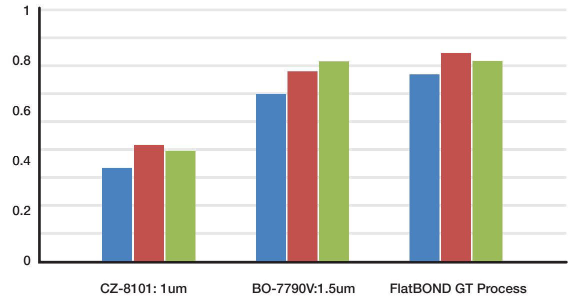
Now installed at a major PCB Manufacturer

FlatBOND GT Copper Treatment for High Frequency Signal Applications

- The ultimate chemical bonding, no micro-roughening
- Produces a profile-free surface for complete signal propagation
- A powerful, proven enabler for next-gen high frequency designs > 25 GHz
- Highest achievable bond strength on low Dk resin systems



Transmission loss for FlatBOND GT Process is about 10dB/m less than that for other treatments at 50GHz.



Peel strength of FlatBOND GT Process is higher than that of roughening treatments for all materials evaluated.

UYEMURA INTERNATIONAL CORPORATION

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