

MID Technologies

Innovative Plating Solutions for LDS MIDs

Judy Ding & Boen Li

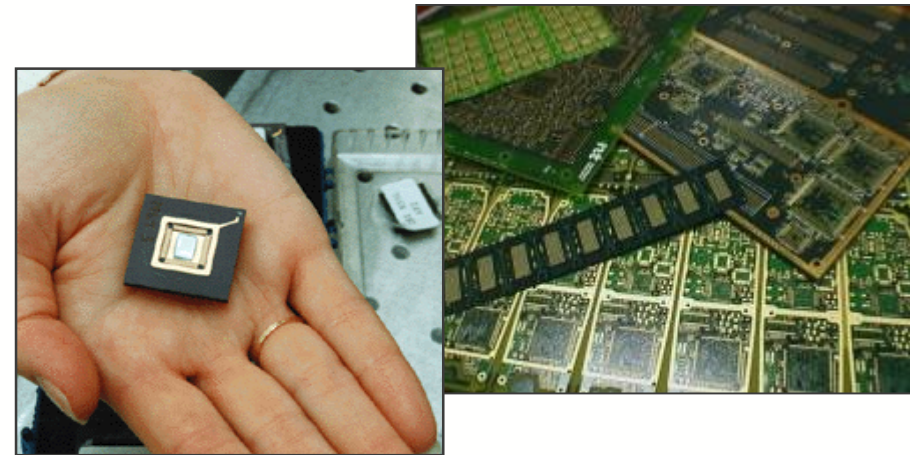
MacDermid Alpha Electronics Solutions

- Over 2000 Worldwide Employees in 23 Countries
- Over 3500 Customers Served Worldwide by Direct Sales/Service Organizations
- Regional Centers of Expertise

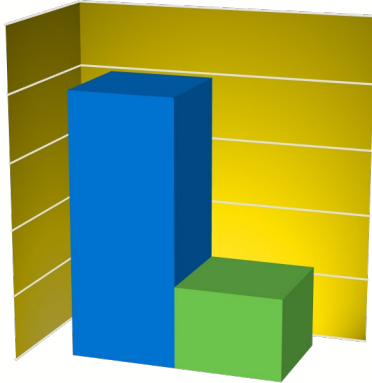
Industrial Solutions



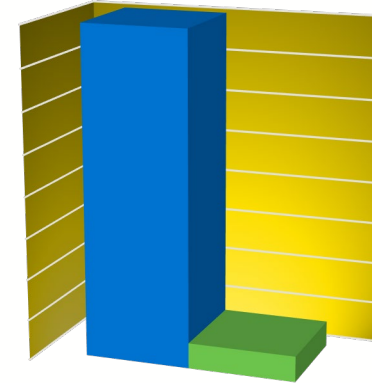
Electronics Solutions



Our Commitment to Technology



■ 2014 EBITDA
■ 2014 R&D Investment



■ 2014 Revenue
■ 2014 R&D Investment



In 2014, We spent an industry-leading 7.8% of our revenue on R&D.



Electronics Solutions Enabling Technology



MacuSpec VF Series
Viafilling Electrolytic
Copper Metallization

M-Speed
Chemical System for
High Speed Innerlayers

MID
Selective Electroless
Metallization for Molded
Interconnect Devices

AFFINITY
Electroless Nickel/Immersion
Gold Technology

STANTEK PC SERIES
Electrolytic Tin Plating
for Passives

BLACKHOLE
Through Hole and Blind Via
Metallization Technology

Worldwide Coverage



- Our regions of MID expertise

MID Piloting Capabilities in Technical Center



- Modern, clean, and well-equipped facility serving as “proof source” for MacDermid global research and as key demonstration site for key customers and OEMs.

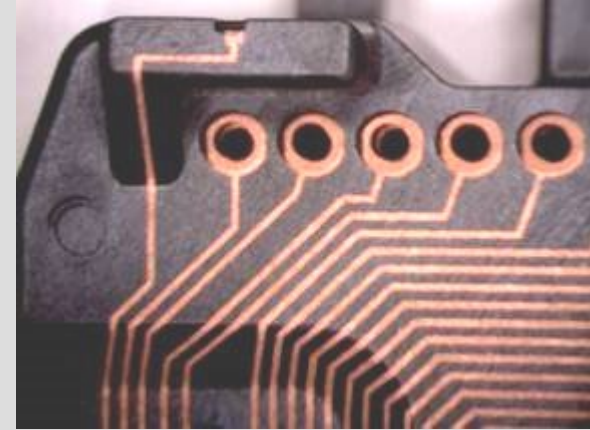
- Small scale (40 liter) barrel piloting dedicated to electroless copper MID plating enables fast confirmation of developments combined with close to real-world loading and plating conditions

MID Metallization Solutions

Plating on Plastics
Used for Decorative
and Functional
coatings



Electroless Copper for Electronics



A combined expertise in POP and electronics plating applications remain crucial in the development and optimization of MID plating processes.

MID Technology

- Molded Interconnect Device (MID)
 - Defined as an injection molded thermoplastic substrate which incorporates a conductive circuit pattern
 - integrating mechanical and electrical functions
- Today's Market
 - Growth in MID is a result of advances in plastic materials and the development of Laser Direct Structuring (LDS)
 - Majority of production volume still remains in antennas for mobile communication devices including mobile phones, laptops, tablets, etc.
- Growth opportunities in additional markets
 - Automotive, medical, lighting, consumer goods
 - Opens up capabilities in design and function
 - New options for miniaturization for form and fit



Smart phones



Laptops



Medical



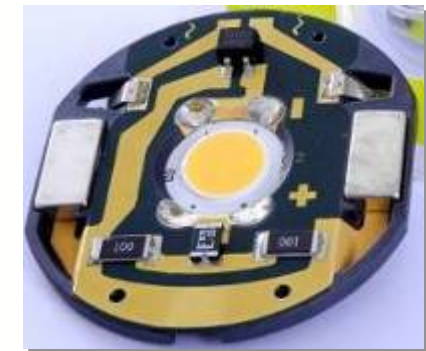
Lighting



Automotive

MID Industry Drivers and Trends

- Fine Pitch Technology
 - Opens design capabilities
 - Miniaturization
- SMT Capability
 - Reflow resistant plastics
 - Solderable surface finishes
- Wire bond capability
 - Proper choice of plastics, plating thickness, surface roughness and final finish
- Lighter design
 - Integrating circuitry with existing part to reduce number of components
- Power and Style
 - Integrating circuitry to provide opportunities for future designs



Copper Innovations



- Improved surface roughness
 - MID Copper X1 process
 - Better surface appearance, smoother deposit
 - Improved SMT and wire bond performance
- Fast plating speed
 - MID Copper 100 XD process
 - 50% reduction in plating time
- Improved Adhesion to emerging plastics
 - MID Copper 100 XD process
 - Enhanced adhesion to PC substrates
- Improved manufacturing plating process
 - MID Copper 100 XB process
 - Optimized plating capability on LDS substrates
 - Initiation, stability = high yields, lower cost

Improved Manufacturing Performance

- MID Copper 100 XB process provided industry with
 - A novel Strike copper process
 - Complete uniform initiation on LDS substrates
 - Consistent predictable plating rates
 - Stable process chemistry, long bath life
 - Eliminated skip plating issues
 - A novel Build copper process
 - Consistent predictable plating rates
 - Stable process chemistry, long bath life
 - Eliminated over plating (extraneous) issues
 - Fully analyzable stabilizer package

MID Copper 100 XB – Key MID Plating Priorities MacDermid Enthone

Common issues effecting manufacturing yields



Skip plating



overplating



Tank plateout

Development




Results

 Yields

 Productivity

 Ease of Use

 Operating Cost

Improved Adhesion

- MID manufacturers began to migrate from PC/ABS to PC substrates.
- PC (polycarbonate) substrates offer improved impact resistance.
- Challenges with adhesion of the plated deposit began to be reported.

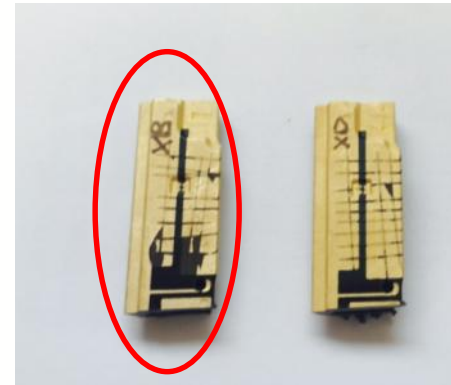
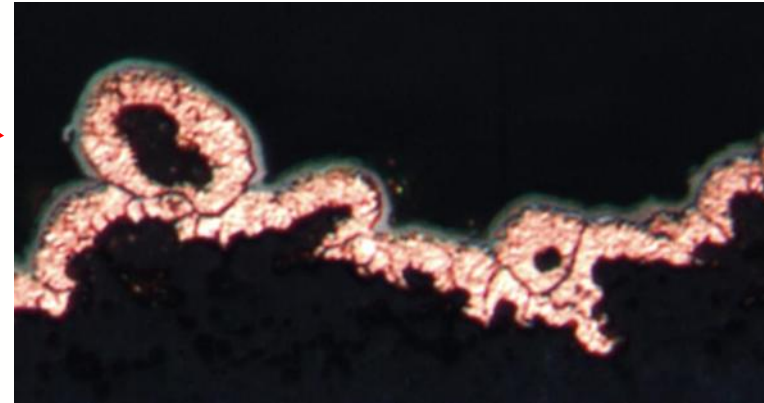
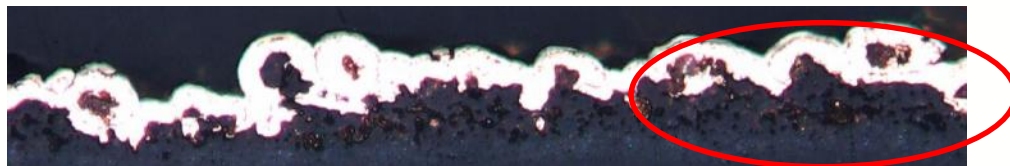
- **MID Copper 100 XD** process developed to provide improved adhesion to PC MID substrates

XB Sample



Cu grain structure after peroxide etch.

Light Adjusted for Plastic



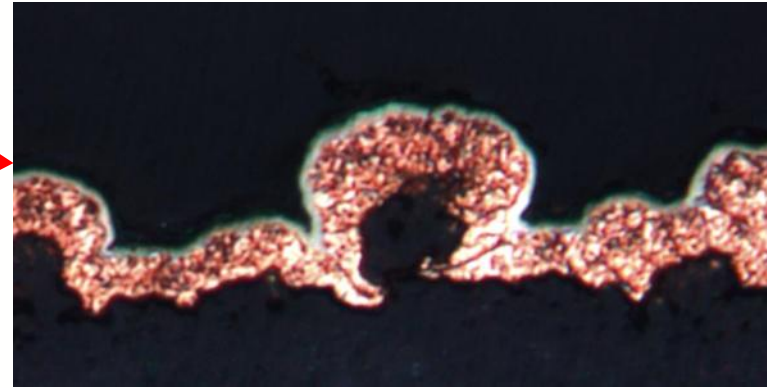
- Note delamination within PC substrate due to plating chemical attack
- Associated with failed tape testing

XD Sample

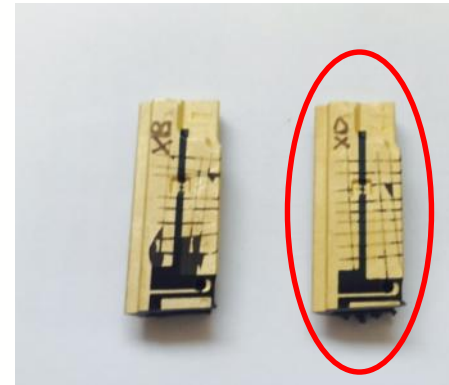
Light Adjusted for Copper



Cu grain structure after peroxide etch.

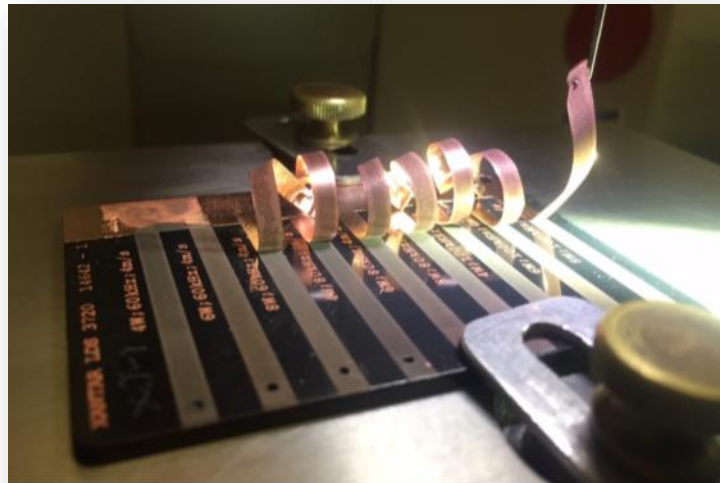
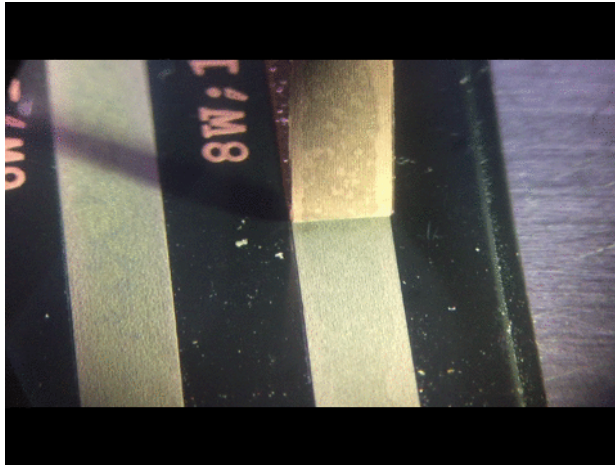


Light Adjusted for Plastic



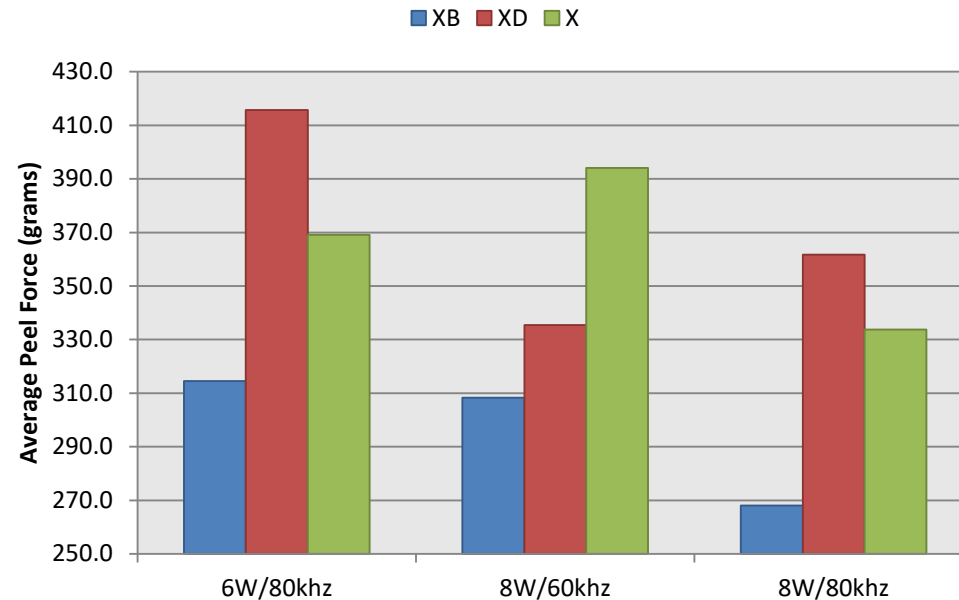
- No visible signs of delamination within LDS PC substrate.
- Improved adhesion verified by industry standard tape testing.

Improved Adhesion



Digital Peel Test – XYZTEC Condor

MID Cu Formulations - Peel Force vs. Laser Condition

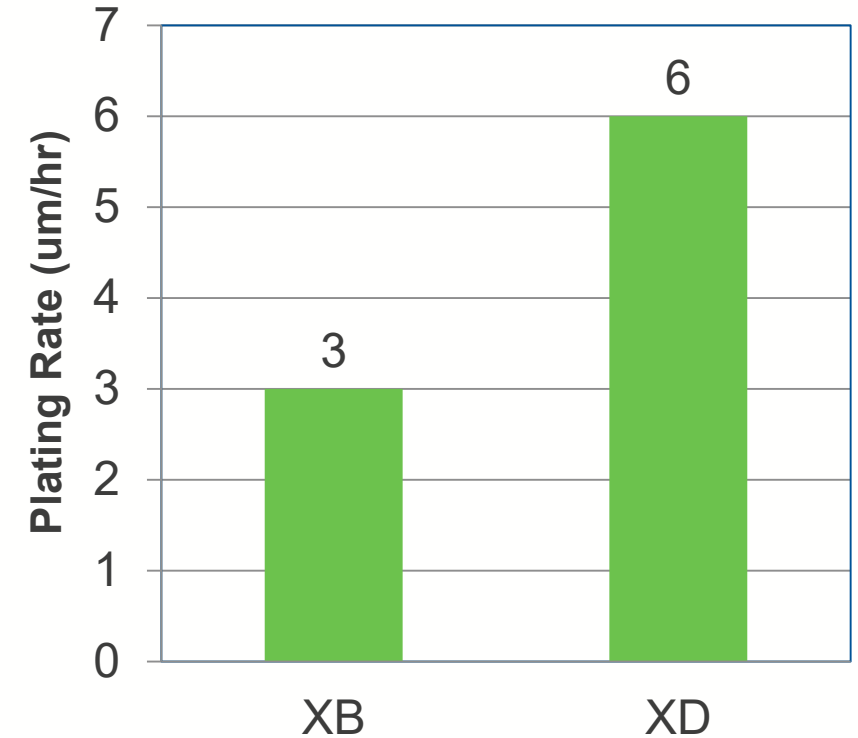


- Adhesion of electroless Cu is quantitatively tested using a highly sensitive digital pull apparatus.
- MID XD and X1 copper have improved adhesion on PC plastics with all commonly utilized laser structuring powers.

Improved Speed

- Responding to demands for increase throughput.
- MID Copper XD process doubled the plating speed without negative impact on stability or bath life.
- Further increase production output without negative impact on quality.
- Lower overall running cost by maintaining stability and high speed.

Plating Rate of Cu Bath

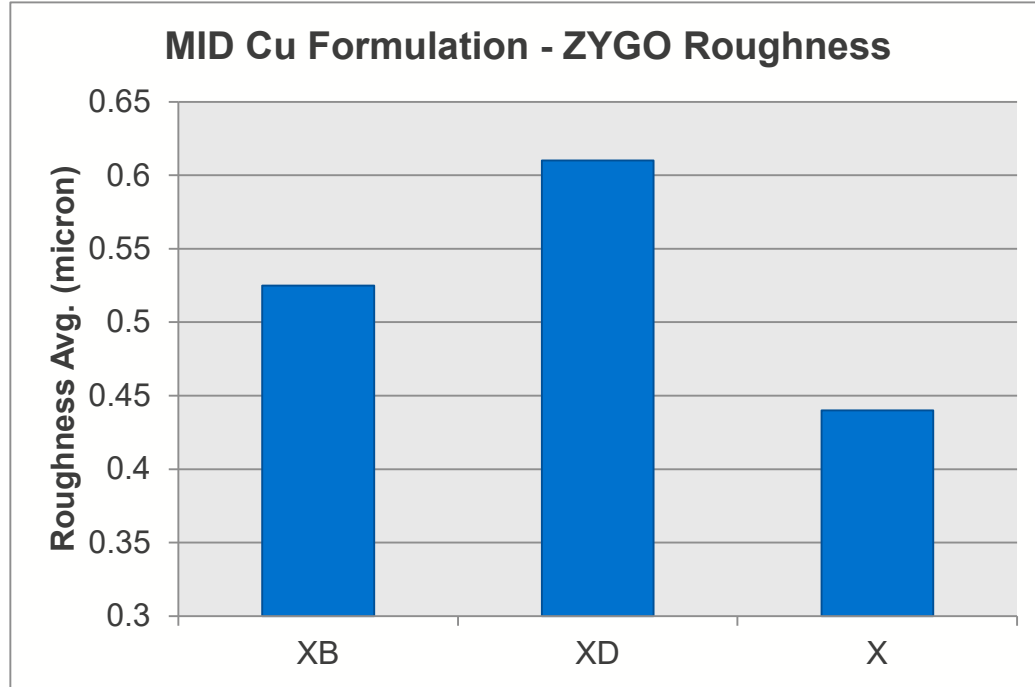


Electroless Cu at 55C

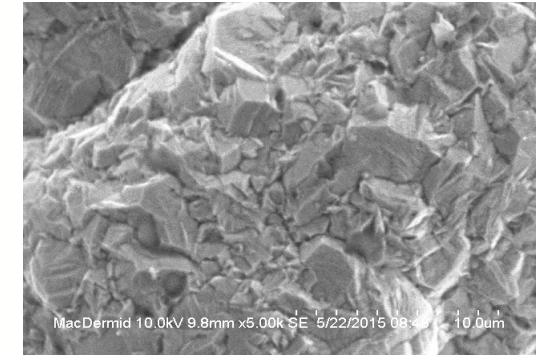
Improving Surface Roughness

- Surface roughness can be a challenge as MIDs are used in new applications.
- Roughness of the plated deposit may affect SMT and wire bonding requirements.
- Plated deposit roughness is linked to the roughness of the activated plastic.
 - LDS surfaces are rougher than DS surfaces
- **MID Copper X1** process provides a smoother, fine grain, and “shiny” copper deposit.

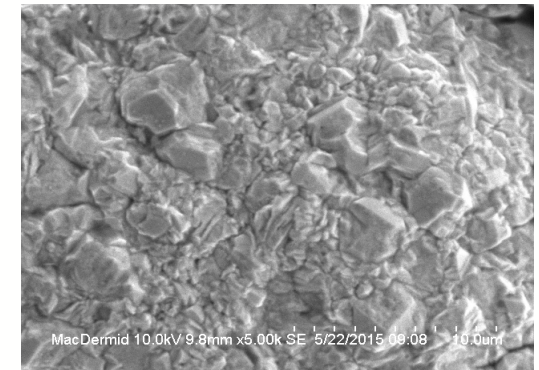
Improved Surface Roughness



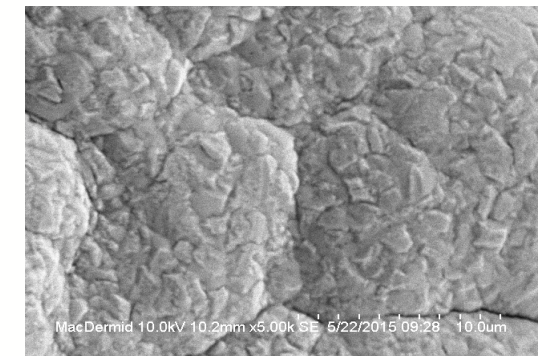
- MID X1 Copper has a lower surface roughness than previous MID Cu formulations.
- MID X1 Copper has the same improved adhesion as XD combined with the surface smoothness needed for attractive cosmetics.



XB

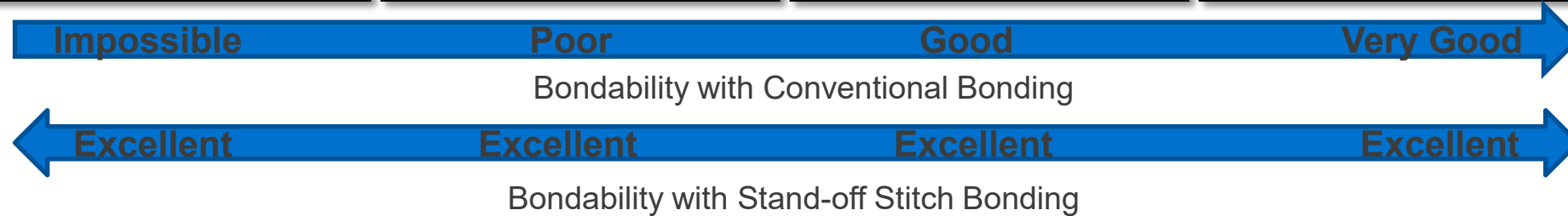
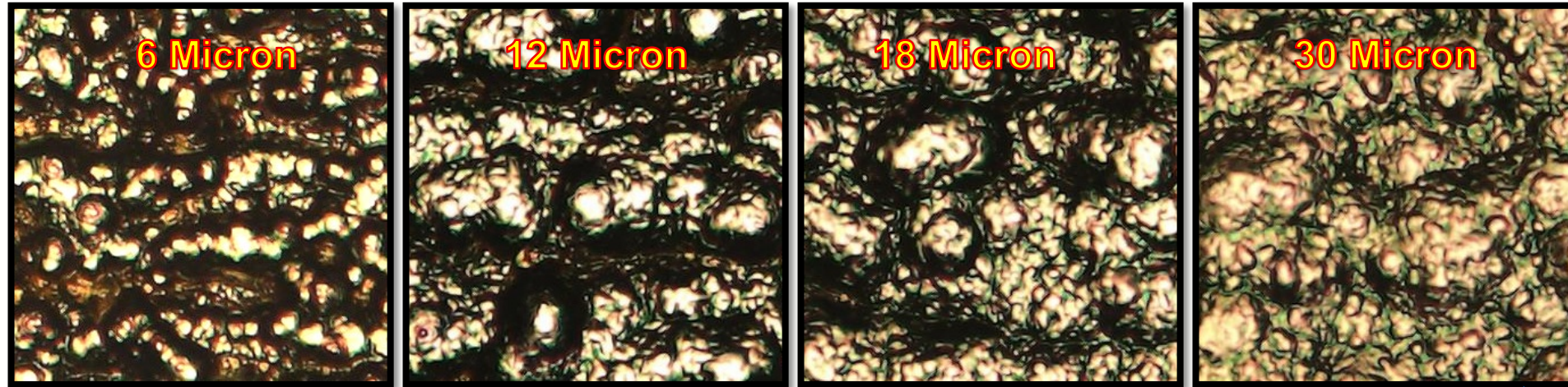


XD



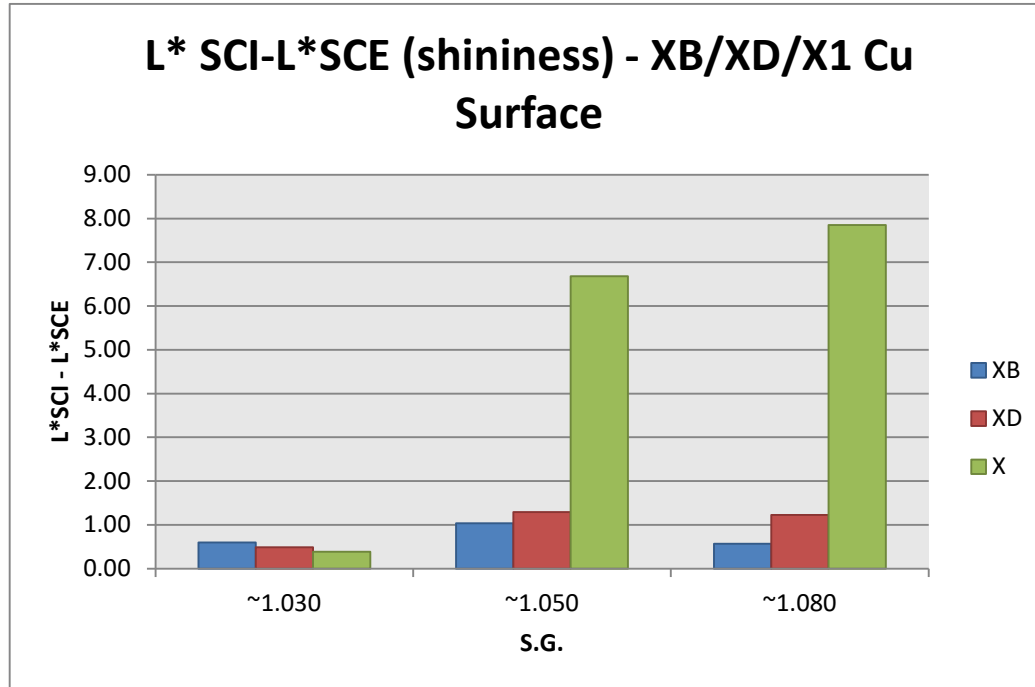
X1

Benefits of Improved Surface Roughness



- Optical microscope shows the surface gets visibly smoother as Cu thickness increases.
- Conventional wire bonding improves with thickness.
- Conventional wire bonding will improve with smoother structure.
- *Stand-off stitch bonding can be successfully applied for all thicknesses.*

Improved Surface Reflectivity



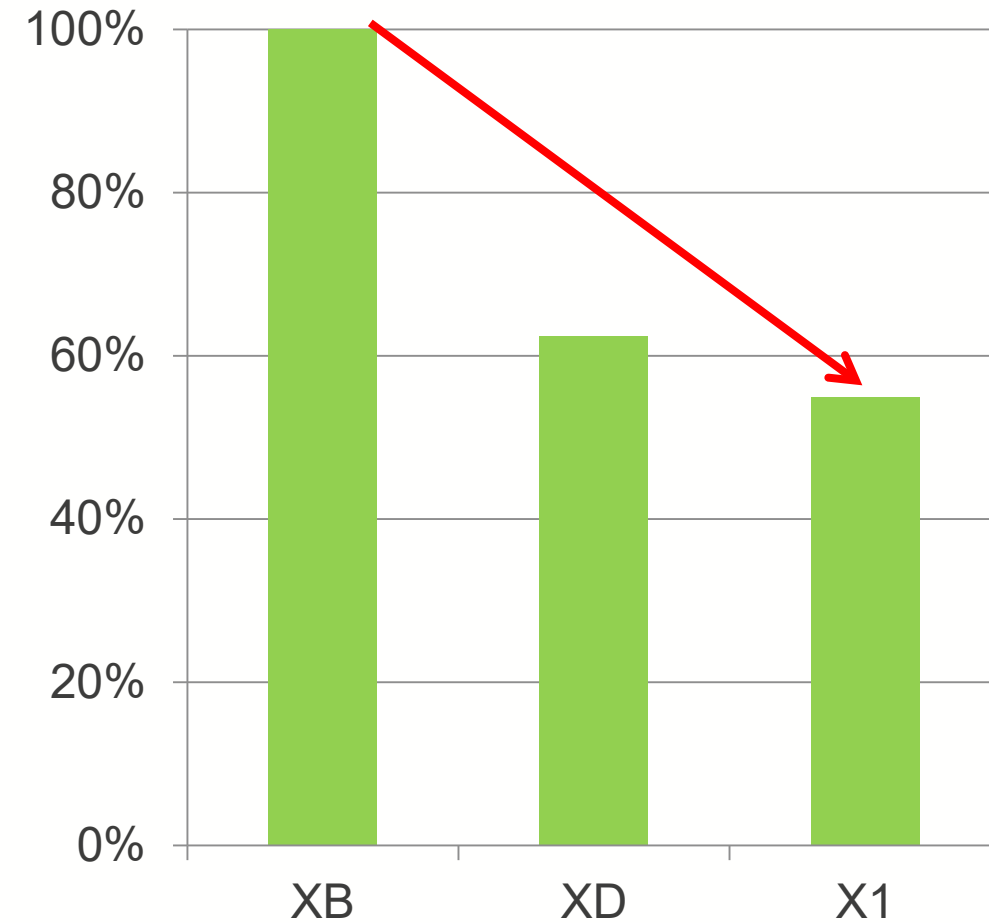
Konica Minolta CM-2600d Spectrophotometer

- MID X-Copper has improved glossy surface appearance vs. older formulations.

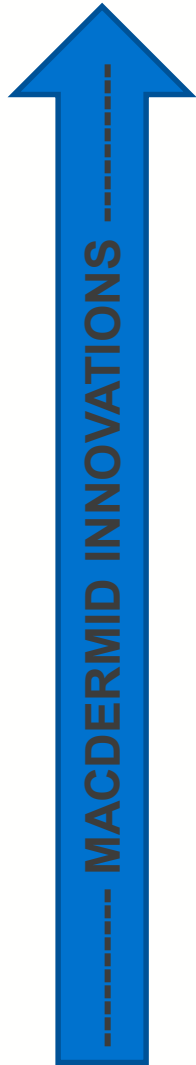
Improved Running Cost

- Continuous product development leading to reduced running cost.
- Lower running cost achieved through improved speed and optimized running conditions and extended bath life.
- Maintain high yield!

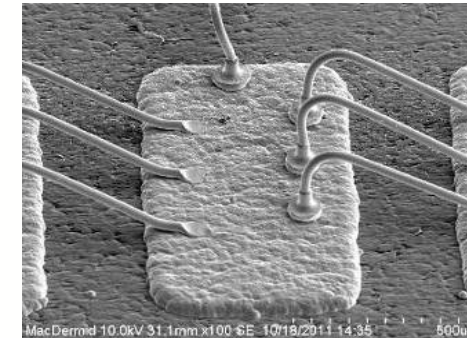
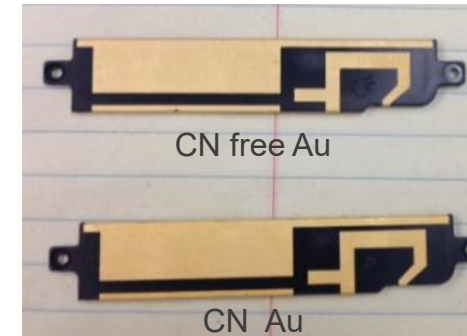
Relative Running cost



Innovations in Final Finishes



- MID Gold 100 CF
 - A true CN free gold finish
 - Low operating temp, 40C
 - Neutral pH
- MID Palladium 100
 - Wire bondable finish for emerging MID applications
- MID Silver 100
 - Low cost alternative to ENIG
 - Excellent solderability
 - Non cyanide process



There Are No Limits to MID

