

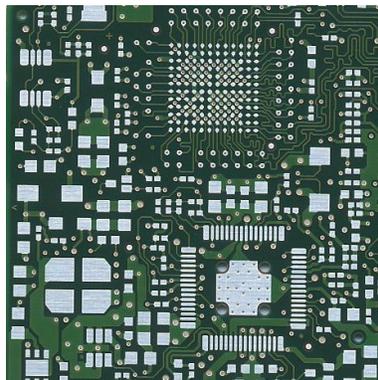
STERLING SILVER PROCESS OVERVIEW

Metallic Solderability Preservative

WHAT IS STERLING?

Sterling Metallic Solderability Preservative is a Final Finish process for Printed Circuit Boards. Sterling was originally designed to fill the need of board fabricators to replace Hot Air Solder Leveling (HASL) with a simple, low-cost process. Sterling exists as an alternative to the more complicated electroless metallization systems that also can be used to replace HASL. After 15 years of successful production usage throughout many end use markets, Sterling Silver is known as a viable final finish for more than just HASL replacement.

Sterling offers a flat, consistently solderable surface that may be applied with high productivity in conveyORIZED equipment, and with little additional engineering support.



Sterling deposits a very thin layer of nearly pure silver that allows for superior solder wetting, extended bare-board storage capability, and surface contact functionality.

STERLING CHEMICAL PROCESS

		Conveyorized	Immersion
Final Finish Acid Cleaner	50 °C	30 sec	5 min
Final Finish Surface Prep	35 °C	60 sec	60 sec
Sterling Pre-Dip	38 °C	30 sec	30 sec
Sterling Silver	50 °C	60 sec	60 sec

LOW COST

Sterling is based on immersion silver technology. The selection of immersion technology results in the deposition of a very thin amount of metal without risk of extraneous plating on dielectric areas. The thinness allows for low-cost as well as the ability for quick processing. This means high productivity. A thin metal coating also means that the solder will form a Cu/Sn intermetallic; the preferred solder joint in electronic packaging.

Silver is a precious metal. While silver is more expensive than many metals, it is far less expensive than other metals commonly used in electronic packaging. The prices of some pertinent metals as of January 2013 are listed below:

Metals	Price
Gold	\$1675.00 per troy ounce
Palladium	\$702.00 per troy ounce
Silver	\$30.35 per troy ounce
Nickel	\$0.44 per troy ounce
Tin	\$0.75 per troy ounce

The appeal of nickel diminishes when it is revealed that a coating of gold is needed when soldering, in order to prevent nickel oxidation. In addition, 40 times as much nickel thickness is used on PCBs than is required of silver. Tin does not provide the extended shelf life or multiple assembly process steps that are achieved with Sterling.

(ref: "Alternative Finishes for PWB - an ITRI/October Project" IPC Expo 1997)

STERLING PERFORMANCE CHARACTERISTICS

Numerous studies have been conducted to characterize the fabrication and assembly performance of the Sterling process. Some specific topics are discussed below.

SOLDERABILITY

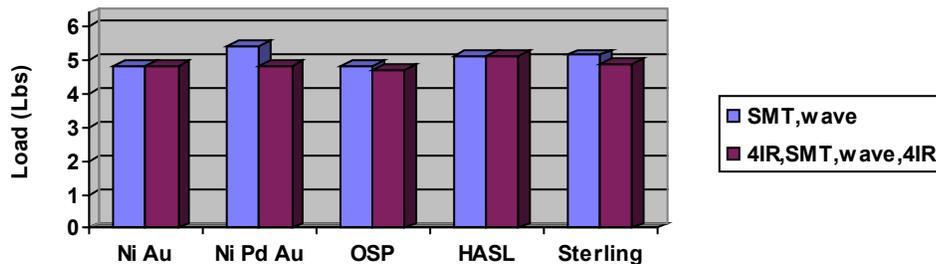
Silver is one of the most wettable metals with eutrotic Sn/Pb and lead free SAC305 soldering. The wettability of silver is due mainly to the quick dissolution of silver at soldering temperatures. The dissolution rates of PCB metals are given below:

Dissolution Rates of PCB Metals in Solder

Metal	Temperature °F	Dissolution Rate μ inches/sec.
Gold	450	117.9
	486	167.5
Silver	450	43.6
	525	97.0
Copper	450	4.1
	525	7.0
Palladium	450	1.4
	525	6.2
Nickel	700	1.7

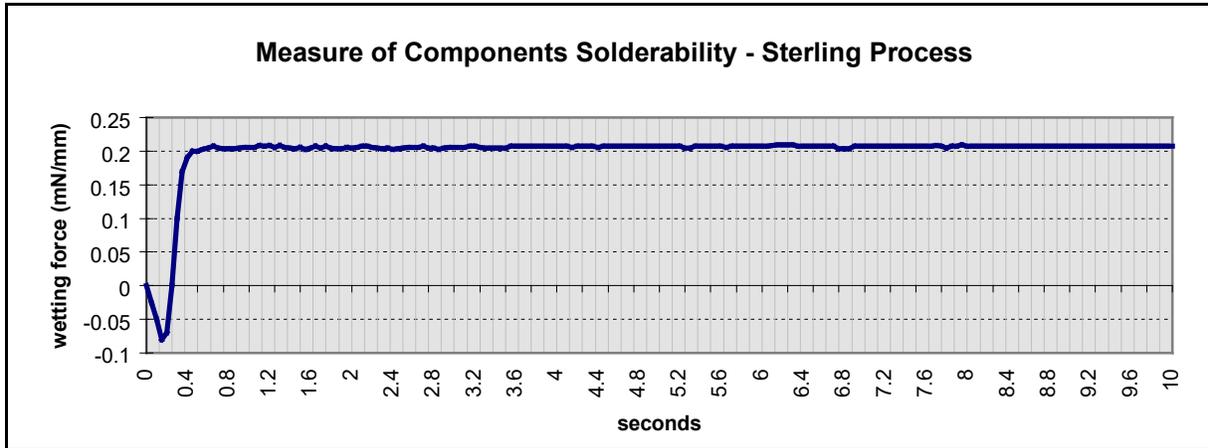
Solderability has been thoroughly investigated according to several industry specifications. Briefly, superior solderability has been demonstrated using solder rise, paste spread, wetting balance, SERA, and most importantly, in real-life assembly.

Solderjoint Pullstrength of PCB Surface Finishes
50 mil pitch, 20 I/O SOIC's





Wetting Balance measurements also show superior wetting characteristics as given in the following representative graph. The coupon measured below was aged 24 hours at 85 °C/85% RH.



HIGH PRODUCTIVITY; EASY PROCESSING

Sterling is an easy process. The silver bath itself has been formulated by MacDermid Enthone R&D staff to perform in the demanding PCB fabrication environment with little engineering support. The bath is easily maintained through the addition of concentrated replenishment chemicals. The bath is extremely stable and is not sensitive to light, heat, or other conditions common to the PCB fabrication shop.



US Patent #5,733,599 and other patent applications obtained by MacDermid Enthone, Inc. cover the unique technology used in the processing of the Sterling Metallic Final Finish.

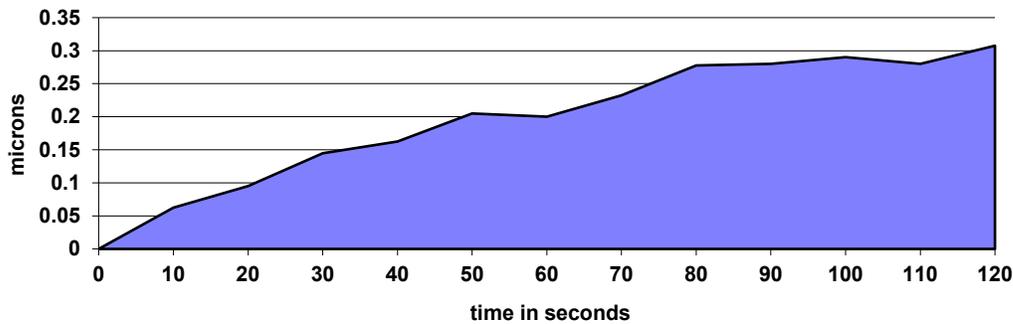
Sterling represents technological breakthroughs in the deposition of a robust immersion metal coating. The process used in the deposition of this finish is equally innovative, resulting in a system that is extremely user friendly and predictable.



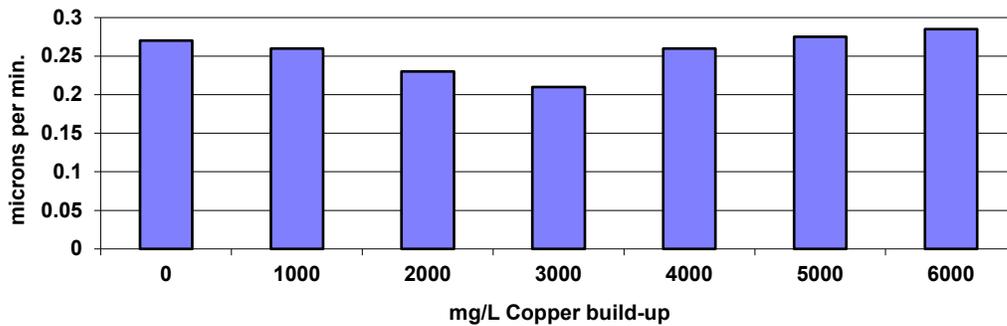
RATE

The rate of metal deposition onto the copper surface is important for several reasons. Primarily, it is important that a minimum amount of 0.15 micrometers (6 microinches) is deposited at all areas to protect underlying copper. Secondly, the thickness distribution is important to ensure that the standard process may be used to reliably reach the minimum thickness repeatedly. Lastly, process speed is important so that high productivity may be obtained in small-footprint equipment. Sterling offers a 1 minute process time in the silver bath and a 5 minute cycle time overall. Within these parameters, a typical thickness of 0.25 ± 0.05 micrometers (10 ± 2 microinches) is obtained. This rate holds very steady with age and natural fluctuation of the chemical bath.

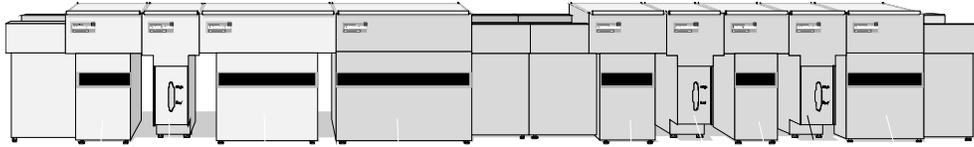
Sterling Deposition Rate



Sterling Deposition Rate as Bath Ages



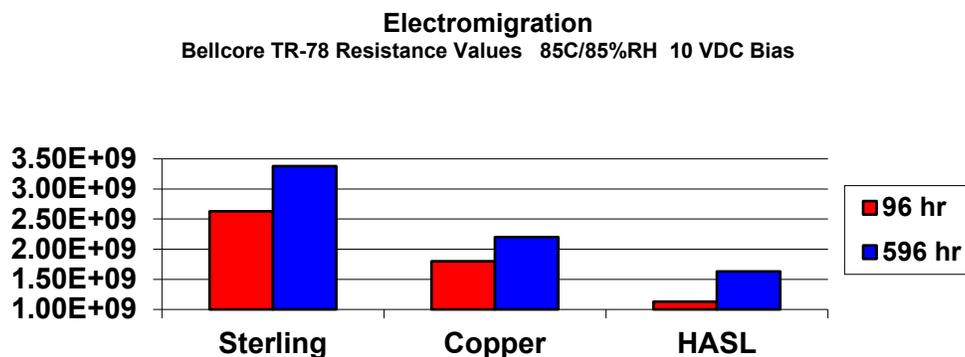
EQUIPMENT



MacDermid Enthone's product development team has worked with our internal equipment specialists and our equipment manufacturing partners around the world to provide complete process specifications and blueprints for our customers. Sterling may be applied both vertically and horizontally. The conveyorized equipment set consists of flood immersion, automatic replenishment, and all plastic construction. The speed of the chemical process allows for affordable equipment prices.

ELECTRICAL PROPERTIES

A considerable literature base exists on the topic of silver as an electronic material. The first concern of a PCB engineer will be silver migration. Further investigation into this topic is warranted by the fact that there will always exist some PCB designs that call out for areas of exposed silver after full component assembly. Test points, tooling holes, and optional componentry may all lead to this condition. The reason for concern lies in the property of silver to form water-soluble salts when exposed to condensing moisture and electrical bias.

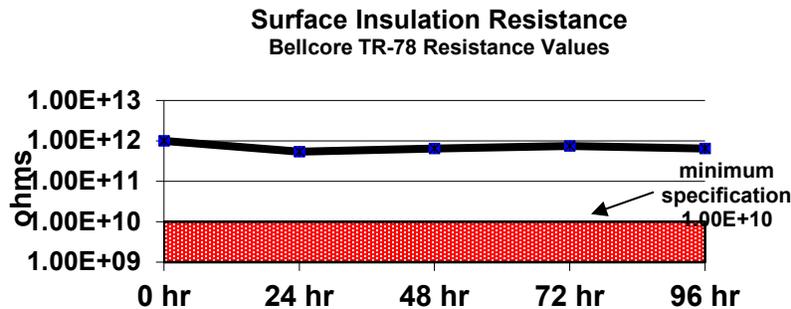


Sterling was formulated with electrical performance in mind. The careful use of grain refining additives and surface active agents yielded a surface finish resistant to the effects of humid environments. The Cu/Ag junctions as well as the interface between silver and the environment are treated to prevent resistance loss.

The Sterling process has undergone testing to verify its ability to perform as a sound electrical connection. MacDermid Enthone's internal laboratories, PCB fabrication facilities, and



independent test laboratories have all performed electromigration and SIR testing to show that the unique Sterling deposit meets pertinent industry specifications.



While Sterling is primarily intended as a HASL alternative, the deposit does allow for a certain amount of additional functionality. In particular, the finish may be used as a contact surface for touchpads, etc. and as a platform for aluminum wire-bonding. And unlike OSPs, Sterling's conductivity and flatness is ideal for electrical test points.

PROCESS CAPABILITIES

Soldermask Compatibility: Sterling is a low-temperature, low-cycle time, non-alkaline process. There is no deleterious affect on soldermask or coverfilm.

Laminate Compatibility: Similar to soldermask compatibility, Sterling is non-invasive to laminate substrates and will not deposit on plastic. All substrate materials are compatible with Sterling.

Flux/Paste Compatibility: Sterling is easily soldered with any available wave-solder flux or SMT solderpaste. This is especially important in today's no-clean environment.

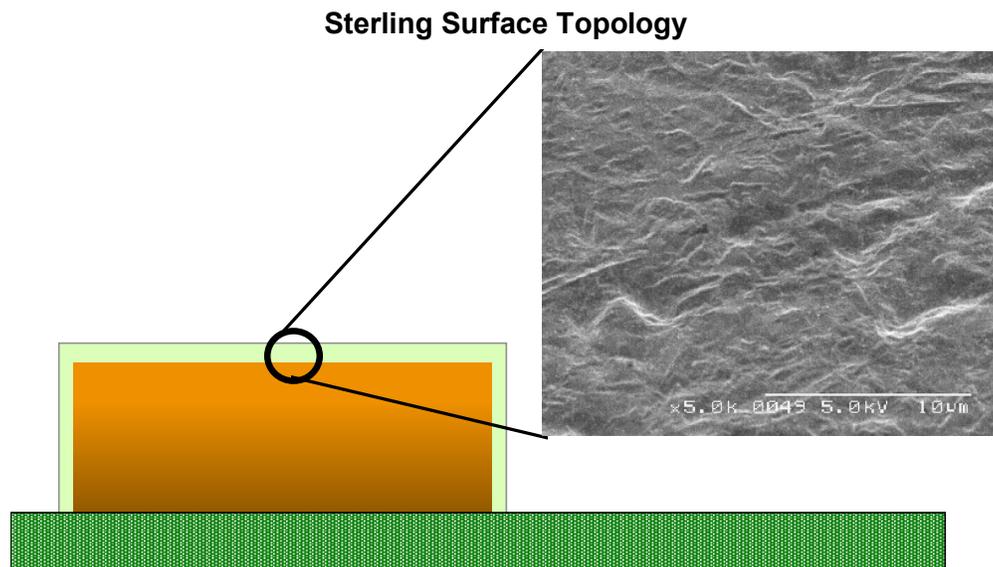
Handling: Sterling looks like a flat HASL finish. The surface is tolerant to minor handling, routing, and punching operations, but may be sensitive to scratches due to the thinness of the coating. Unlike other silver-containing finishes on the market, Sterling holds its color and luster for long periods of exposure to the environment and does not turn yellow with handling.

INDUSTRY SPECIFICATIONS

Sterling has been tested according to the following industry specifications.

MIL-STD-55-110E

- Bellcore
- IPC-J-STD-003
- Alcatel Lucent
- Ford

**LITERATURE AVAILABLE**

Process Literature, including Technical Data Sheets, MSDSs, and processing specifications are available to potential customers and end-users by contacting the MacDermid Enthone Incorporated.



CONTACT INFORMATION

To confirm this document is the most recent version, please contact
techinfo@MacDermidAlpha.com

www.macdermidalpha.com

<p>North America 245 Freight Street Waterbury, CT 06702, USA 203.575.5700</p>	<p>Europe Elisabeth-Selbert-Str. 4 40764 Langenfeld, Germany 49.2173.8490.0</p>	<p>Asia 8/F., Paul Y. Centre 51 Hung To Road Kwun Tong, Kowloon, Hong Kong 852.2499.7299</p>
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