## Circuit Technology



James P. Langan • J.P. Langan & Associates, Inc. 7 Mayflower Drive • Red Bank, NJ 07701 • 732/842-3741

## High-density Interconnection Surface Finish Issues

Limitations of HASL

For the past 30 years, the most preferred PWB surface finish has been fused tin/lead. Reflowed solder plate was first used until the need for solder mask to be applied over copper for optimum reliability initiated a switch to hot-air solder leveling. HASL has been the preferred surface

Surface Finishes (TMRC Data)						
Percentage						
	1994	1995	1996	1997	1998	1999*
HASL	71.5	75.3	72.9	59.7	67.8	67.0
Sn/Pb reflowed	10.0	5.2	4.1	5.0	2.7	1.4
OSPs	12.7	15.9	17.3	28.2	19.2	21.4
Ni/Au	3.8	1.5	2.0	5.8	8.3	8.0
Other	2.0	2.1	3.7	1.3	2.0	2.2
	100.0	100.0	100.0	100.0	100.0	100.0

\*Estimate

finish because it has no visible evidence of dewetting, displays a bright, shiny appearance, and solderability is assured when the coating meets thickness specification.

Limitations of HASL that have caused PCB manufacturers to contemplate other surface finishes are planarity concerns and compatibility with new bonding techniques. The fabrication industry is familiar with OSPs and nickel/gold electroplating. Other finishes under consideration, however, require a learning process to achieve maximum functionality. Rapidly gaining acceptance is electroless nickel/gold. This method mandates stringent control to assure solderability and bondability.

Other techniques with potential to provide planarity and remain compatible with the bonding process are electroplated Ni/Pd, Pd and electroless Ni/P, Pd, immersion Sn and immersion silver. These prescribe non-conventional procedures, a learning curve and scrupulous control to assure dependability.

Flat-fused solders (SSDs) provide planarity and a precise volume of

solder for attachment of ultra-fine pitch components, but assume special equipment and precise photoimaging. SSDs have the potential to solve some of ultra-fine pitch attachment shortcomings if cost can indeed be controlled.

Design for manufacturability implies a synergistic approach involving teamwork among engineers in design, assembly and PWB fabrication. The importance of firstpass yields dramatically increases as design, material and techniques are upgraded to exaggerate the benefits of recent advancements in semiconductor technology.

Currently, no HASL replacement enjoys the same confidence of assemblers accustomed to solderability assurance when the coating meets thickness specification, has no visible evidence of dewetting and is bright and shiny.

The desire for a lead-free electronic industry, coupled with the need to accommodate efficient attachment of components with greater than 200 I/O, prompted the increased use of "ultra" fine pitch components. A side

Free Details: Circle 121 on reader service card or visit www.aesf.org/psf-qwiklynx.htm. effect, however, placed in jeopardy tin/lead dominance as the preferred surface finish.

In 1996, HASL was used on 73 percent of printed circuit boards produced in North America. The following year revealed significant increase in OSPs and Ni/Au as a result of planarity concerns with ultrafine pitch components and new bonding methods incompatible with HASL.

Close observation of IPC's Technical Marketing Research Council (TRMC) data on surface finishes from 1994 to 1999 reveals that the dramatic increase in OSPs in 1997 did not continue into 1998. The most likely explanation suggests that assemblers experienced a decrease in first-pass yields on applications using "no clean" fluxes and limited OSPs to applications where planarity was essential for placement of ultra-fine pitch components.

When the 1997 data was finalized, an OSP increase for 1998 was

projected. Upon prediction failure, the ensuing 1999 estimate was more conservative.

It should be noted that alternatives to HASL currently under evaluation, such as immersion tin, immersion silver, Ni/Pd and flat-fused tin/lead, have not yet gained appreciable share of the market. These finishes have certain advantages for specific applications, including:

- Ni/Pd finishes can function as a contact surface and are wirebondable (whereas a soft gold is required for wire bonding and a hard gold for contact).
- Immersion silver and immersion tin are reported to be less fragile than OSPs and better suited for visual inspection.
- SSDs are ideal for TAB bonding of ultra-fine pitch components.

These approaches are in limited production and with improvement of process controls, anticipatory utilization is projected for applications requiring their specific technical advantage.

The surface finishes capable of providing the planarity and bondability needed for ultra-fine pitch and advanced attachment techniques do not have the luxury of HASL's facile verification for solderability.

The surface finish issue, therefore, is one requiring a synergistic approach where assemblers continue to perfect attachment techniques to accommodate alternatives to HASL and fabricators work to improve process control for quality assurance.

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Call: 407-281-6441 FAX: 407-281-6446 E-mail: editor@aesf.org