

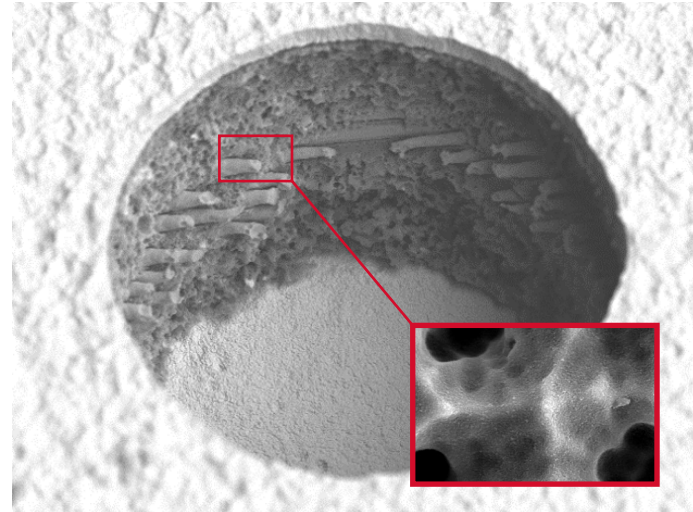
Blackhole LE

Low Etch Carbon-Based Direct Metallization System

Direct Metallization: the Next Evolutionary Step for mSAP

Blackhole LE is the choice of fabricators worldwide that are looking to bring the environmentally responsible and reliable direct metallization technology into the production of high-density interconnects for mobile designs.

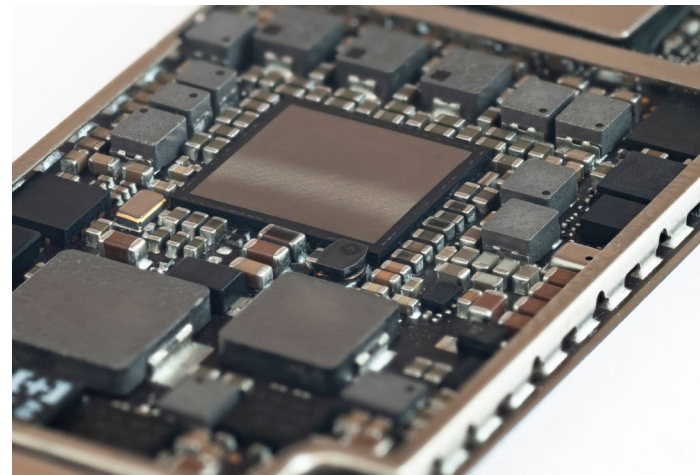
Trusted by over 250 of the world's leading manufacturers, the original Blackhole technology has decades of proven success as a leading direct metallization technology. With the equipment and chemical upgrades of Blackhole LE, the exceptional reliability for conventional HDI is now bringing a revolution to modified Semi-Additive Processing. With minimal etching and pristine copper micro via target pads, Blackhole LE allows for a higher quality manufacturing process with fewer additive copper steps and a leaner copper etch budget.



Laser drilled micro via (Inset: Blackhole LE conductive residue selective coating of nonmetallic surfaces only)

KEY FEATURES

- Low etch technology that enables direct metallization for mSAP
- Selectively coats innerlayer materials leaving copper target pads completely clean for electroplating
- Enables direct electroplating to micro via target pad without intermediate layers
- Improves copper etch budget for better trace definition
- Equipment and chemical upgrade to existing direct metallization processes
- No chelators, formaldehyde or added metals
- Compatible with a wide range of board materials

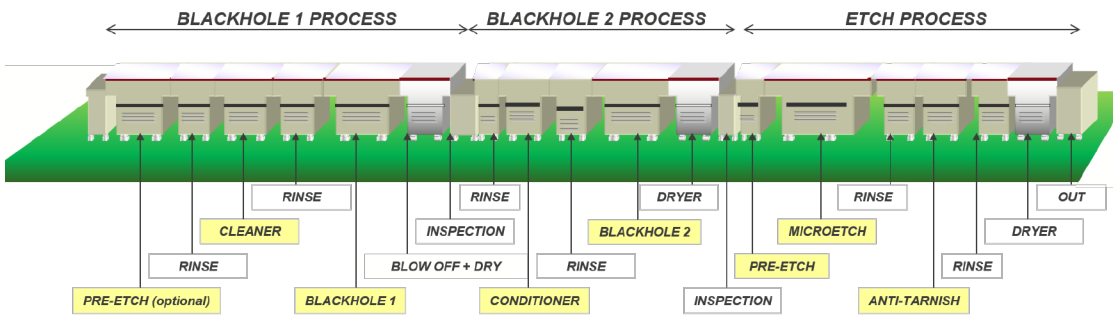


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The Technology and History Needed to Meet Today's HDI

Until now, direct metallization processes lacked sufficient advantages to be considered a worthy replacement for electroless copper processing in today's high-density mobile board manufacturing. Through extensive chemical optimization, groundbreaking micro via reliability studies, and broad equipment development, these revolutionary primary metallization processes are now proven replacements. Compared to low build electroless copper and flash plate, Blackhole LE high-density interconnect technology results in fewer layers of additive copper. The low etch technology of Blackhole LE allows it to completely clean the carbon activation from micro via target pad copper surfaces. The result is more precise manufacturing and tighter tolerances, better trace morphology and less variation.



Existing Blackhole lines can be upgraded to Blackhole LE with equipment modification and chemical replacement.

Extensive Micro Via Reliability Data

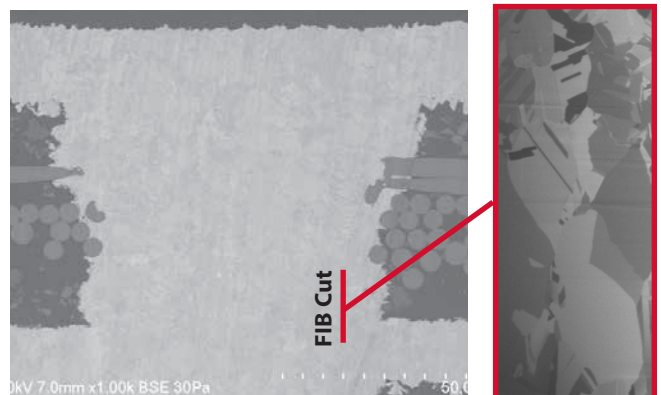
Micro Via IST Testing Results

Statistic	P2%	Cycles	S2%	Result
Ave	1.7	1,000	1.96	Pass
Min	1.9	1,000	1.97	Pass
Max	1.5	1,000	1.95	Pass
STDEV	0.28	0	0.01	Pass

Solder Shock Testing Results

Test Methodology	Qualification	Example Photo
Through Hole Solder Shock 10x, 288°C	100% Pass	
Microvia Solder Shock 10x, 288°C	100% Pass	

FIB-SEM Grain Structure at Target Pad Interface



Blackhole LE technology enables modified Semi-Additive Processing of high density innerlayers with just a single additive copper step. When compared to low build electroless copper and flash plating, this evolution of mSAP reduces the total number of copper grain types at the critically important via target pad interface from three to just one.



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