

Entry Board For HDI Microvia Drilling

by Thomas S. Michels,
TMT Group of companies

The development of high performance electronic devices have resulted in the demand of high density of fine lines on the printed wire board and IC substrate, which leads to the decrease of hole size and the increase of hole number. However the traditional entry boards for drilling, such as Al foil or phenolic board, become less suitable for the drilling of small holes because of the high demand of drill quality and accuracy for the small holes. Therefore a new functional aluminum based entry board has been developed to enhance the accuracy of drill and to reduce the broken rate of the drill bit. Thus reducing the cost of drilling drastically. This article concentrates on the influence of entry boards and drills for HDI drilling and the influence of specialized entry boards for the drilling of filled and halogen-free laminates.

Technology trends regarding drill size, density and aspect ratio

- Today's so called small hole diameters are 0.2mm for HDI mass production. The future diameters and in countries with leading technology e.g. Japan and Korea already today, is 0.07mm
- The hole density of 32 holes/cm² will arrive at a level of 100 holes/cm² in the very near future
- The layer count of 2-12 layers

Table 1 – Influence on accuracy

	Entrance 1500 H	Exit 1500 H	Holewall	Nail heading	Productivity
Φ 0,2mm, 125000 Rpm/min	+/-31µm	+/-68µm	8 µm	152 %	100 %
Φ 0,2mm, 180000 Rpm /min	+/-32µm	+/-74µm	10 µm	148 %	120 %
Φ 0,3mm, 125000 Rpm /min	+/-22 µm	+/-33µm	10 µm	148 %	100 %
Φ 0,3mm, 160000 Rpm /min	+/-20 µm	+/-40µm	6 µm	162 %	125 %

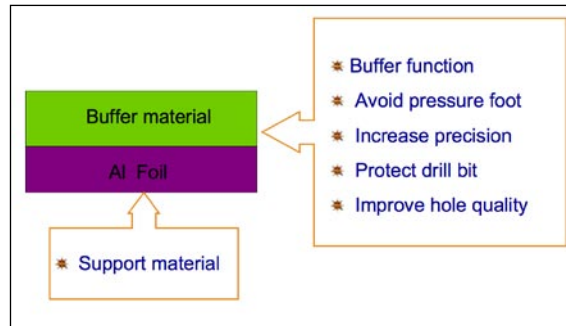
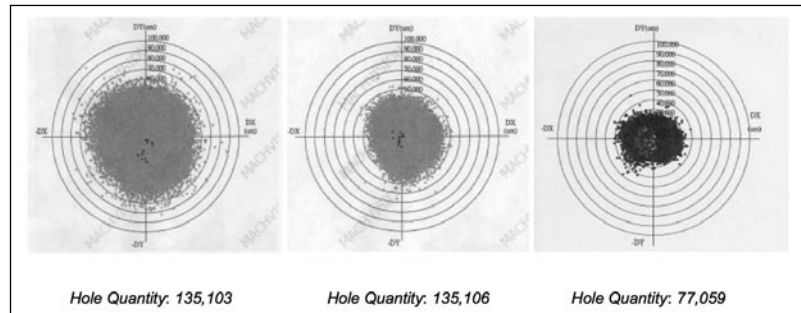


Figure 1 – Lubricated aluminium

Figure 2 – Comparison of entry board in drill



goes to 12-18 layers

- The laminate thickness drives from today average of 1.6mm to a thickness of 0.2mm-1.2mm in the future.

High performance Laminates

Special materials have a market share of less than 20% of PCBs produced in Europe today. Future designs, complexity and applications will drive today's "special materials" to become a standard in the future.

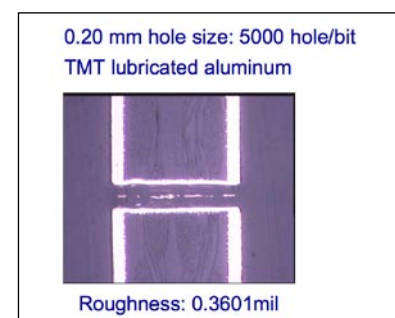
The European PCB market has changed to be more and more a market for small and medium sized volumes. As a result the fine tuning of soldering lines is less and less normal. Thus requiring laminates have to have bigger working lat-

itude. In order to keep stock levels low without increased lead time for delivery most PCB manufacturer concentrate their variety of used laminates to two products - one for standard applications, while the other one has to fulfill all non standard specifications. For non standard applications there are two products in Europe: halogen-free and phenolic.

Halogen-free

Developed for the Japanese market for marketing purposes, the

Figure 3 – Hole roughness



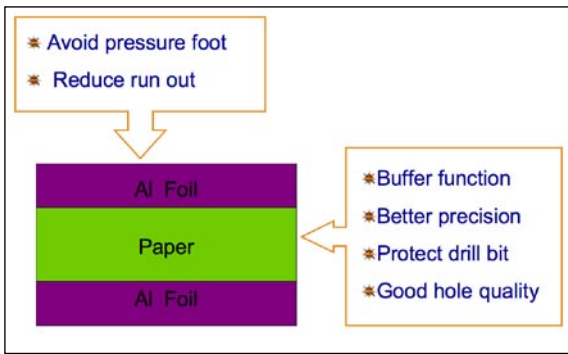
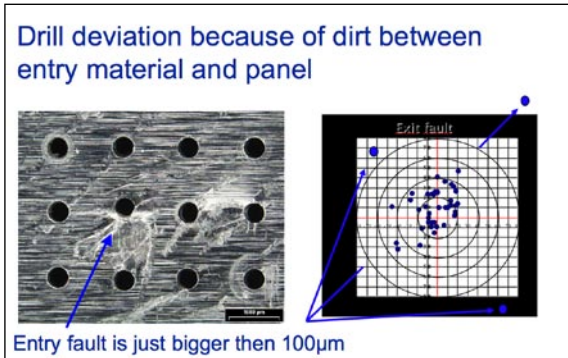


Figure 4 – Aluminium/paper/aluminium
Figure 5 – Drill package preparation



material showed the side effects of being thermally more stable and improved z-axis stability. Typical applications are the telecommuni-

cations and mobile phones and in Europe the automotive and computer industry. Today the global market share of halogen-free material is between 4-6%. The European market share at 1-2% is even lower.

Phenolic

Developed during the early 80's due to increased demand for thermally resistant materials, this material showed massive problems when sulfuric acid hole wall cleaning was

used. This led captive manufacturers to delist the material, setting a trend for the industry which resulted in a ban of the product. Af-

ter numerous trials to implement Tg 170 laminates as an answer for lead-free soldering issues, the phenolic materials have gained more and more market share. Today's market share is in the area of 12-15%.

Conducted test

The aforementioned miniaturization and the switch to so called 'filled material' resulted in reduced yield, reduced efficiency and therefore increased cost. The following data and pictures are based on the material and equipment used. They are meant as a suggestion to provoke thoughts about the reasons for the regularly observed issues. Also it provides an example of how a PCB manufacturer could improve the quality/cost situation by using a 'best of the best' approach.

A pre-testing group of companies agreed on the following products:

- *Entry board* – Lubricated Aluminium from TMT group of companies (Figure 1)
- *PCB* – 10 layer Multilayer, halogen-free and phenolic laminate from Technolam, Germany
- *Back-up* – 2.0mm melamine laminated material from TMT group of companies
- *Drills* – 0.2mm and 0.3mm HAM 380 SBR SZ AC drills from HAM Precision, Germany
- *Equipment* – MX2-200S from Schmol, Germany.

	Hits		
Rpm: 125000 U/min; Infeed 1.2 m/min	500	1000	1500
Deviation entrance +/- 3 σ	24µm	29µm	31µm
Deviation exit +/- 3 σ	46µm	62µm	68µm
Nail heading	134 %	136 %	152 %
Holewall roughness	5 µm	6 µm	8 µm

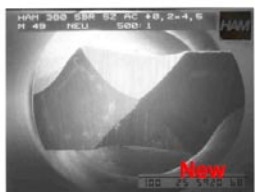
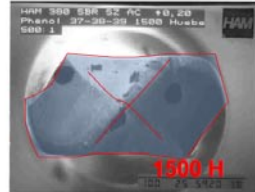
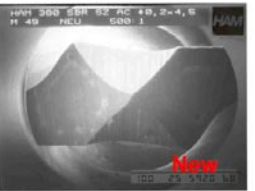
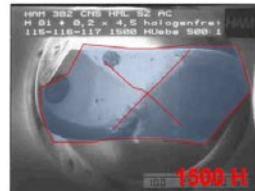



Figure 6 – NP 175F TL diameter 0.2 mm drill wear
Figure 7 – NPG diameter 0.2mm drill wear

	Hits		
Rpm: 125000 U/min; Infeed 0,5m/min	500	1000	1500
Deviation entrance +/- 3 σ	24µm	24µm	24µm
Deviation exit +/- 3 σ	30µm	37µm	44µm
Nail heading	126%	125%	127%
Holewall roughness	16µm	14µm	18µm

During the pre-testing phase 3 different entry boards were tested. The main reasons to concentrate on the lubricated material were the drill bit accuracy (Figure 2) and the hole wall quality even after 5000 hits, with standard FR-4 (Figure 3).

An Aluminium-paper/Aluminium composite (Figure 4) showed acceptable results regarding drill bit accuracy but had increased drill breakage and no improvement regarding drill bit life cycle and hole quality. It's also important to mention that the drill package prepa-

	Hits		
Rpm 125000 U/min Infeed 0.5 m/min	500	1000	1500
Deviation entrance +/- 3 σ	24μm	24μm	24μm
Deviation exit +/- 3 σ	30μm	37μm	44μm
Compared to standard FR4:		1000 H	2000 H
180000 U/min 2.2 m/min Exit +/- 3 σ:		35μm	42μm

Figure 8 – NPG diameter 0.2 mm drill wear

Figure 9 – NP 175F TL diameter 0.2 mm drill wear

	Hits		
Rpm 125000 U/min Infeed 1.2 m/min	500	1000	1500
Deviation entrance +/- 3 σ	26μm	29μm	31μm
Deviation exit +/- 3 σ	46μm	62μm	68μm
Compared to standard FR4:		1000 H	2000 H
180000 U/min 2.2 m/min Exit +/- 3 σ:		35μm	42μm

ration is vital in order to receive a perfect result regarding burr, accuracy and drill breakage (Figure 5).

The tests showed significantly increased drill wear (Figures 6 & 7) which resulted in a 50% decrease of accuracy for the halogen-free and phenolic material (Figure 8 & 9).

Nevertheless the accuracy was acceptable due to an improved centering when the lubricated exit material in combination with the AC Type drill bit of HAM was used.

Also nail heading was not an issue at all for either laminate (Figure 10 & 11). For both materials an increase of speed by using faster spindles showed a 20-25% improvement in productivity. Whereby the influence on accuracy was slightly negative (Table 1).

The summary of the conducted test is as follows:

- The use of halogen-free and phenolic materials in combination with HDI is a challenge for the me-

chanical drilling.

- The lifetime of the drills is reduced significantly
- The feed rates are reduced significantly
- Optimized drills have to be used in order reduce wear and accuracy
- Optimized entry materials have to be used in order to keep drills cool and therefore reduce wear of drills
- Optimized entry materials have to be used in order to improve accuracy
- Optimized back up regarding thickness tolerance and surface hardness has to be used
- Faster spindles have to be used in order to get lost productivity back.

All the above mentioned results lead to higher cost. With the right combination of equipment and materials the PCB manufacturer has an opportunity to at least reduce this increased cost by significantly improved quality and yield.

	Hits		
Rpm 125000 U/min Infeed 0.5 m/min	500	1000	1500
Deviation entrance +/- 3 σ	24μm	24μm	24μm
Deviation exit +/- 3 σ	30μm	37μm	44μm
Nail heading	126%	125%	127%
Holewall roughness	16μm	14μm	18μm

Figure 10 – NPG diameter 0.2 mm hole quality

Figure 11 – NP 175F TL diameter 0.2 mm hole quality

	Hits		
Rpm 125000 U/min Infeed 0.5m/min	500	1000	1500
Deviation entrance +/- 3 σ	24μm	29μm	31μm
Deviation exit +/- 3 σ	46μm	62μm	68μm
Nail heading	134 %	136 %	152 %
Holewall roughness	5 μm	6 μm	8 μm