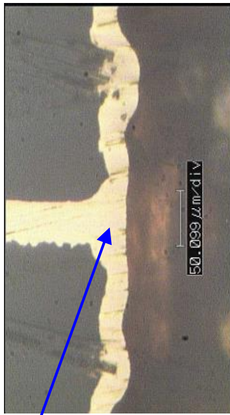
UNION TOOL EUROPE S.A.

NAILHEADING

The distortion of the copper inner layer at the hole wall, this distortion takes the form of a "Nailhead". There are several types of nailheads; the most common type seen on small hole diameters is a thermal/mechanical nailhead. The thermal/mechanical nailhead is produced by excessive heat and the drill bit pushing and pulling the copper in each direction the drill bit travels. Drill sizes above 0.75 mm diameter are susceptible to thermal/mechanical and only mechanical nailheading. Mechanical nailheading is characterised by a heavy resin smear over the copper.

CAUSES:

1. Incorrect infeed.
2. Incorrect spindle speed (min^{-1}, RPM).
3. Incorrect retract rate.
4. Under cured resin.
5. Drill bit clogging.
6. High elongation copper.
7. Entry or backer material.



NAILHEADING

CORRECTIVE ACTIONS:

1. Determine type of nailhead, single sided or bi-directional nailheading.
2. Single sided nailheading;
   Reduce infeed rate, or increase min^{-1} (RPM).
   Bi-directional nailheading, reduce min^{-1} (RPM) or increase infeed rate.
3. On small diameter drills retract rates may be reduced.
4. Check the drill bit for clogging, clogging of the flutes can be caused by drill bit design, aluminium entry sticking to the drill, under cured resin or backer material.
5. High elongation copper foils will increase nailheading, the higher the elongation of the copper the more severe the nailheading will be.
6. Some entry and backer material will adhere the drill bit causing hole wall quality problems.

MIS-REGISTRATION

The alignment of the respective inner layers to the other inner layers or the drilled hole. Mis-registration is the out of alignment of one or more inner layers to the remaining inner layers or the drilled hole.

CAUSES:

1. Photo tool incorrectly used or punched.
2. Material shrinkage during etch or lamination.
3. Location of tooling holes on drill table off in relation to panel tooling holes.
4. Drill machine positions incorrectly (runs short or long).
5. Drill spindle has excessively high run out.
6. Drill bit deflects on entry or through drill stack.

CORRECTIVE ACTIONS:

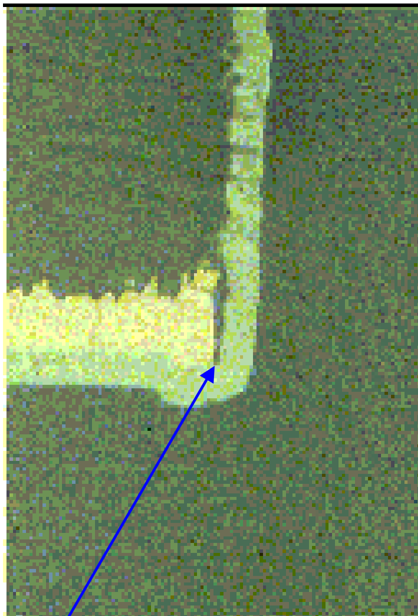
1. Re-tool photo tools-check for proper use.
2. Size artwork to compensate for shrinkage, correct shrinkage on core material.
3. Make new set-up on drilling machine.
4. Service drill machine to move to correct distances, size drill program.
5. Change collet in drill spindle or change drill spindle.
6. Change entry material, speeds and feeds, or drill bit design.

SMEAR

Resin transferred from the base material of the hole wall during drilling covering the exposed edge of the inner layer pad (land). There are two types of resin smear, like nailheading, the thermal mechanical smear is created by excessive heat and is clear in appearance. The mechanical smear is heavy coating over the inner layer land with a colour similar to the resin system being used.

CAUSES:

1. Under cured resin.
2. Excessive spindle speed (min^{-1}, RPM).
3. Excessive infeed during drilling.
4. Drill depth into backer.
5. Dull drill/chipped drill.
6. Under cured resin in backer material.
7. Incorrect smear removal process.



CORRECTIVE ACTIONS:

1. Verify the cure of the resin system.
2. Verify min^{-1} (RPM) note, the most common practice to determine correct min^{-1} (RPM) is to calculate min^{-1} (RPM) for a given drill size based on a pre-determined surface speed per minute formula. The industry standard is 150 m/min., however as the base material becomes harder the SFPM is reduced to 140 m/min., or less.
3. A very high infeed rate while drill will create a heavy resin covering the inner layer copper. This smear will have the same colouring as the base material being drilled. This usually occurs on drill sizes larger than 0.75 mm. The infeed rate is to high, reduce the infeed in increments of 20% until the problem is corrected.
4. Adjust drill depth into backer to proper level, (1 ½ times the drill diameter). Excessive drill depth into the backer will create unnecessary heat resulting in smear.
5. Dull/chipped drills create heat resulting in smear. Drill should be retired when recommended flank wear land is achieved. Chipping can be caused by improper drill bit handling, incorrect infeed rates, and improper entry materials.
6. Under cured resin in the backer material will transfer to the inner layer conductor.
7. Smear removal processes, which are too weak o spent will not adequately, remove smear. Make necessary additions or increase time in smear removal, or if plasma etch back make necessary changes to gasses and or time in vacuum chamber.

RESIN FRACTURING (HALOING) SURFACE

Damage to resin in the proximity of the hole wall. The damage may be “surface” or “hole wall fractures”. Surface fractures are visible without the aid of cross sectional analysis, and will usually be accompanied by disruption of the outer layer copper material. Hole wall fractures occur between conductor layers and usually require cross sectional analyses for detection.

SURFACE FRACTURES ARE CAUSED BY:

1. Infeed rate too fast.
2. Incorrect entry material-Entry material which is very thin will not properly support the drill on entry, allowing the drill to create a burr on the top of the panel which will separate the base copper foil from the resin and create a fracture or crack in the resin.
3. Backer material-If the backer material does not support the PCB properly on exit the material will be pushed out instead of drilled creating an exit burr, which on high temperature materials will usually show a fracture under the copper.

HOLE WALL FRACTURES ARE CAUSED BY:

4. Excessive heat created when high spindle speed is used with slow infeed rates.
5. The resin is under cured.
6. The drill flute clogs with resin, entry material, copper or backer material.

CORRECTIVE ACTIONS:

1. Adjust infeed rate; reduce in increments of 20% until fracture is eliminated.
2. Change entry material to one, which will support the drill on penetration.
3. Change backer material to a harder material. Backer material should be approximately as hard as the being drilled.
4. Adjust spindle min^{-1} (RPM) to correct SFPM and change infeed rate to appropriate level.
5. Verify proper laminate cure.
6. Complete steps 1-5, flute clogging is caused by:
   a. Entry material (aluminium) sticking to the drill (on small diameters) blocking the path of the drill debris evacuation.
   b. High min^{-1} (RPM) and a low infeed rate will cause the PC board's resin to get hot and adhere to the drill.
   c. Drill design, small diameter drills with insufficient flute volume will clog.

PAD (LAND) TEAROUT

Land area being dislodged from base material.

CAUSES:

1. Excessive heat being generated during drilling process.
2. Dull drill, drills used with the incorrect parameters fail prematurely. This will create excessive heat as described in #1 above.
3. Pad to hole size incorrect.

CORRECTIVE ACTIONS:

1. Change drilling parameters (Speed/Feed & hit count) high min^{-1} (RPM) and low infeed rate causes excessive heat which under severe conditions will push the inner layer land down on entry and pull up on retract causing unsupported pads to tear away from “core” material.
2. Unless incorrect drill was used, this problem can only be corrected by change in design of PWB.

WEDGE VOIDS

An attack of the laminate material at the base of the conductor and the interface of the hole wall. Like "Pink Ring" but in the shape of a "Wedge".

CAUSES:

1. Oxide treatment:
   a. Inadequate oxide coverage.
   b. Improper rinsing.
   c. Poor material handling.
   d. Contamination-dirty slip-sheets.
2. Lamination:
   a. Excessive bake before lay-up.
   b. Contaminants from lay-up area.
   c. Out of date prepreg.
   d. Incorrect heat rises or pressures cycle.
   e. Post lam bakes excessive.
3. Drilling:
   a. Incorrect drill parameters (speed and feed).
   b. Entry and backer materials.
   c. Excessive hit count (dull drill) or chipped drill.
   d. Excessive stack height.
4. Hole wall pre/copper deposition:
   a. Excess time in desmear chemical.
   b. Desmear chemical too strong.
   c. Inadequate rinsing.

CORRECTIVE ACTIONS:

1. Correct oxide process to have:
   a. Correct chemical content.
   b. Proper rinsing and drying.
   c. Correct material handling techniques.
2. Correct lamination process for:
   a. Correct pre-lam bake.
   b. Contaminants in lay-up room.
   c. Prepreg with unexpired shelf life.
   d. Adjust heat rise and pressure cycle.
   e. Correct time, temperature and stack of post bake.
3. Drilling:
   a. Adjust speeds and feeds.
   b. Change backer/entry material and/or depth into backer.
   c. Reduce hit count-replace chipped drill.
   d. Change stack height.
4. Adjust time in desmear, strength of desmear and rinse times.

PINK RING

A delamination of the bond between the material and the copper oxide surface of the inner layer copper. This typically appears surrounding the drilled hole but may appear in areas away from the drilled hole. This happens when acid attacks the oxide through a micro delamination.

NOTE: **Pink ring is not a drilling related problem, however it is typically attributed to drilling.**

CAUSES:

1. Insufficient bond between the inner layer oxide and the base material.
2. Bond of inner layer may be affected by depleted chemicals in the oxide process.

CORRECTIVE ACTIONS:

1. Use the oxide reduction process.
2. Replenishment of chemicals on a more frequent bases.

BURRS

The distortion of copper foil on the outer layer(s) of the PCB. Burrs may be either entry or exit burrs, and may be visible on both sides of the same panel.

CAUSES:

ENTRY BURRS

1. Lack of entry material.
2. Entry material to thin for the speeds and feeds being used.
3. Debris entrapment between the entry material and the PCB.
4. The opening in the drill spindle pressure foot is to large, allowing the vacuum to lift the thin entry board.
5. Soft entry material.
6. Poor pressure on the pressure foot.

EXIT BURRS

1. Debris entrapment between the bottom of the panel and the backer board or the next panel in the drill stack.
2. Backer material to soft for material being drilled.
3. Debris clogging the flute of the drill.
4. Poor pressure on the pressure foot.

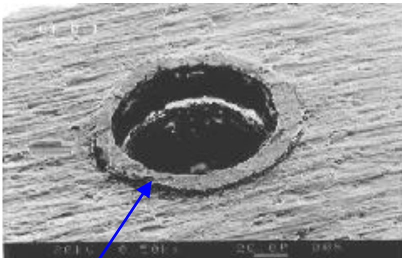
CORRECTIVE ACTIONS:

ENTRY BURRS

1. Use entry material on all drill sizes drilled with a chip load in excess of 0.038 mm (for drills used with less than a 0.038 mm chip load, entry material protects the surface of the PCB from damage and to aid the drill for a more accurate penetration of the board material).
2. Replace entry material with a thicker or more ridged material.
3. Clean the surface of the PCB and the entry material of all debris and dust prior to drilling.
4. Replace entry material with a more ridged material or reduce the amount of vacuum being used.
5. Replace the entry with a harder material.
6. Keep the pressure on the pressure foot to a minimum of 120 N.

EXIT BURRS

1. Clean the backer and the bottom of the bottom panel prior to install on drill table. (All material should be wiped off with a tack cloth before placing on the drill table).
2. Replace backer material with a harder material.
3. Correct flute clogging; (resin cure, entry material, backer material, etc.).
4. Keep the pressure on the pressure foot to a minimum of 120 N.



BURRS