



Film Lamination – Are We Paying Enough Attention?

What's next? How much more technology can they throw at us until we cry uncle? It's well documented that our industry is still using many of the same old products, equipment, and processes from the 70's and 80's to build boards that are now up to 40-plus layers with 3-mil lines and spaces. Some of these designs are as large as 24 by 36" and 0.250" thick. And if you think you can build the board, what is the yield?

Adding up the cost of the new high temperature laminates required to make these products, it's time to find different approaches and techniques.

Here are two such estimates for the cost of laminate and prepreg only for a 36 layer, 21 by 24" and 0.200" -thick PCB:

- Lead Free Tg 180 C with 16 core layers plus 34 prepreg layers = \$160.00
- Lead Free Tg 210 C (HSSL) with 16 core layers + 34 prepreg layers = \$640.00

Moving forward, we need to find answers. This article focuses on one of the key initial steps in fabrication and how to get the desired results. It may not be the most exotic process, but if you don't start correctly, problems will multiply, quickly.

Dry Film Lamination

When I was first introduced into this business, one of my mentors said, "Quality control begins with *the artwork*." Over the years, the process of producing a quality phototool has become well documented and, in most board shops, the phototool is produced very well, with cleanliness being the only real wild card.

Even better, the advent of laser direct imaging (LDI) has truly minimized many concerns of a poorly transferred image to dry

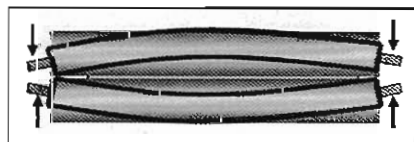


Fig 1 Traditional Type Rollers. The Roll Nip Pressures Vary Across the Circuit-Board Width

film on copper.

The area that now requires more attention is the actual application of the dry film, and ultimately the final image, onto the copper. How do you ensure that film adhesion is adequate and uniform across the entire surface of a PCB? Remember, we are fighting copper tarnish, pits and dents, warped laminate, larger areas, thicker panels, and crazy little features, and again the wild card is cleanliness. If we fail to properly laminate that 3-mil line, and it gets missed at AOI and then pressed into the 14th layer of that 36-layer board, it's over. There is a real loss of up to \$640, plus labor, processing, and overhead costs.

It's time to update that concept – "Quality control begins with *the image and its transfer to copper*."

Traditionally (and again developed in the 70's), we use lamination equipment that was not designed to address large and thick panels and very fine features. Due to the bending of rubber lamination rolls plus weak and variable pressure, adhesion at the center of a panel can be poor. Adhesion becomes better toward the outer edges of

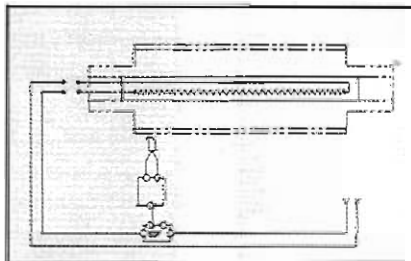


Fig 2 Single Heating Element. Heat is Strong in the Middle But Weaker on the Edges

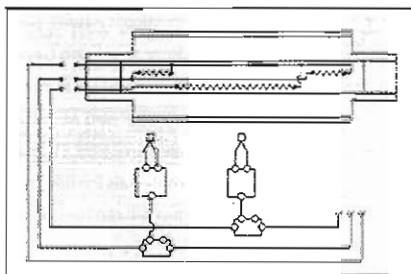


Fig 3 Three Zone Heating Optimizes Control for Even Heat Distribution Over the Entire Surface

the panel but as panels become larger and thicker, the situation worsens. In addition, the single heating element on these older hot roll designs is acceptable in the center but the heating effect begins to deteriorate as it moves to the outer edges.

The crowning of rubber to compensate for uneven pressure has been a good solution but in some ways it is a band-aid for the older roll designs. Weak mechanisms, wear and tear, and a reduction of rubber diameter will still cause uneven pressures. Even when a roll has been crowned with precision, there is wear and tear, making it difficult to apply the right pressure to this changing contour.

Today, we need optimal adhesion — 100 percent of the time — covering every square inch of the board. The newer techniques suggested below minimize the pressure and heat issues and ensure a more direct and simple approach to film lamination with less variables.

Heating Mechanism Comparison

In Figure 3, the roll heaters have separately controlled circuits for the outer and middle

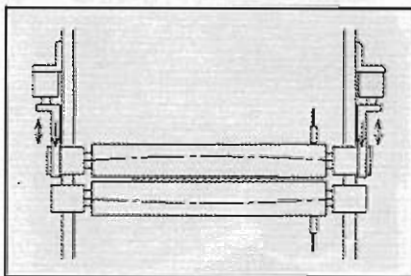


Fig 4 Traditional Systems

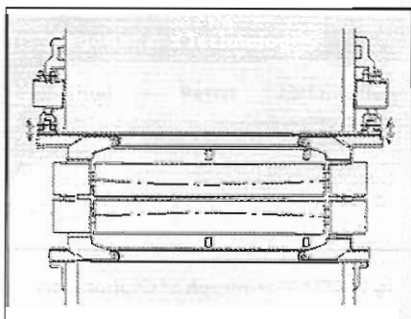


Fig 5 New High Pressure System

parts of the roll, with radiation heat type sensors monitoring each. The laminating roll cores are thicker and the rubber is thinner than on older machines. Together, these updates allow the rolls to recover more quickly and with a more uniform temperature distribution when heat is transferred to the panels during lamination.

As an added attempt to achieve increased adhesion and conformation, customers are beginning to have their rolls recovered with varying rubber durometers and thicknesses. Today, one standard durometer is not optimal for all applications.

Pressure Mechanism Comparison

The roll pressure mechanism in Figure 5 has been redesigned for increased adhesion for dry film lamination. Force is transmitted via pivots from arm bars and bearings to the center part of the rolls, focusing a greater total pressure onto a tighter roll footprint, thus providing high-quality lamination even

at speeds as high as 5.5 m/min. In addition, the roll diameter has been increased and the barrel metal has been made stronger to minimize roll bending. Pressures from 1 bar to 5-plus bar are now possible with virtual uniformity across the entire panel surface.

Oh Yes, the Cleanliness Issue

Although separate from the actual lamination application, pressing dirt into the package is not good. Again there is no real magic here and the most popular approach is the use of standard tacky roll systems. They work well.

What you may not be aware of is the fact that "wet lamination" is an excellent cleaning tool. Although wet lamination is another full topic, many "wetlam" customers are now beginning to eliminate tacky rolls after they have installed the wet lamination kit. In addition to virtually eliminating defects due to pits and dents (on fine lines below .005"), the wet rolls pick up unwanted debris off the copper surface immediately before the

film gets applied. The wet rolls are an excellent attraction mechanism for the debris and with a very easy daily cleaning routine, the process is most effective.

In summation, you cannot afford to gamble with suspect film lamination, and when you walk away from the laminating process as its running, you want to be confident that the film is going on correctly. The film needs to be applied with both uniform high-pressure and heat across the entire clean panel surface. Yields will be affected — positively! ☐

References

Dietz, K. H. "Fine Lines in High Yields (Part CXXXV): The Effects of Lamination Roll Mechanics on Conformation," *CircuitTree*, December 2006

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