

Terry Munson

# Finding Residue Sources: Part I

## Finding residue sources in PCBs using Six Sigma techniques.

**D**orian Shainin, a quality improvement consultant, teaches a problem solving technique called the dictionary search. The premise of the dictionary search is that the source of a problem can be located by subdividing the solution space. This technique has now become part of the Six Sigma methodology.

### The Dictionary Search Technique

Shainin would begin a search by asking a class participant to open a dictionary and choose a word. Without knowledge of the word, Shainin would then ask if the word was between A and M, or N and Z. He would then divide the solution space in half again, and so on. With only 17 questions, he could identify the exact word—one word out of 131,072—chosen by the student. The same technique can be used to search for residue sources in printed circuit board (PCB) fabrication.

### A Case Study—The Problem

A client recently experienced failures during environmental stress testing on rigid multi-layer PCBs. (Figure 1). The failed PCBs had a whitened spot—indicating an inner layer had partially delaminated. The PCBs were then cross-sectioned and completely delaminated for examination. On the ground plane, on layer six of the eight-layer board, a large blister had formed, with subsequent corona, arcing and burning, which indicates that electro-migration of the metal had occurred. Layers three and seven showed no signs of failure.

To solve the problem, we wanted to know what was differences existed chemically between various layers. We also wanted to know if differences existed within each layer. Two locations were compared on each layer—the failure location to a reference (non-failed) location. Several samples were analyzed using ion chromatography per IPC-TM-650, method 2.3.28.

### Root Cause

The following detrimental ionic contaminants were identified: bromide, chloride, sulfate and weak organic acids. The data (Figure 2) showed a significant difference between layer six residue levels and other layers. Moreover, the levels of bromide, chloride and sulfate on layer six were above recommended limits for long-term product reliability.

### Corrective Actions

Working with the client and the bare board fabricator, we found that residues on layer six were originating at the plating line. The client and the fabricator worked together to reduce levels of detrimental residues, and the failures ceased. The fabricator then placed process controls on the plating line.

### Conclusion

PCBs may be forensically examined using Six Sigma techniques, such as the dictionary search, to pinpoint the source of chemical residues left behind during the manufacturing process. In this case, the book of PCB layers, like a dictionary, was re-opened and analyzed. In other cases, the dictionary can be product processed to various points in the manufacturing process. ■

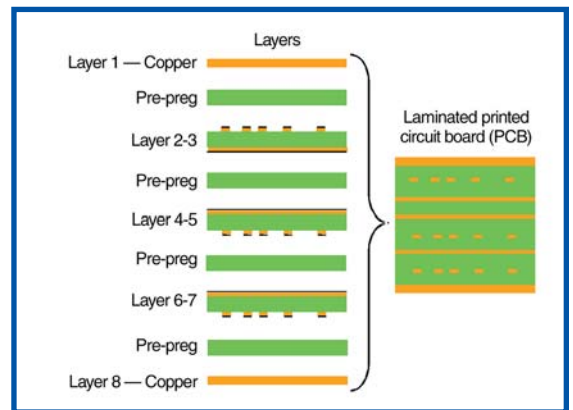


FIGURE 1: Eight-Layer printed circuit board.

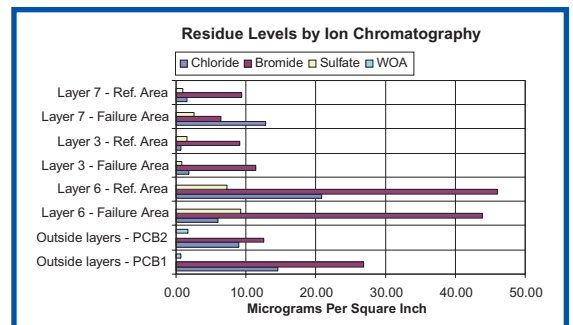


FIGURE 2: Residue levels by ion chromatography.

Terry Munson is with Foresite Inc. (residues.com); tm\_foresite@residues.com. His column appears monthly.

