IPC-9121

# Troubleshooting for Printed Board Fabrication Processes

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Users of this publication are encouraged to participate in the development of future revisions.

Contact:

IPC

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# Troubleshooting for Printed Board Fabrication Processes
## Section 1 – General Introduction

### 1 GENERAL INTRODUCTION

This handbook provides problems, causes and possible corrective actions related to PWB manufacturing processes. To keep this document current, readers are encouraged to submit process problems with photos as well as proposed causes and solutions to the IPC 7-24 Printed Board Process Effects Handbook Subcommittee. Submissions will be considered for document revisions.

**1.1 IPC-9121 Format Example** This document follows the general format seen below. In instances where there is no photo, a photo is not necessary or one could not be found. Readers are encouraged to submit photos which they feel best describe an adverse process effect. Potential test methods for discovery and verification are included in tables where applicable.

**Issue: Photoresist under-exposure**

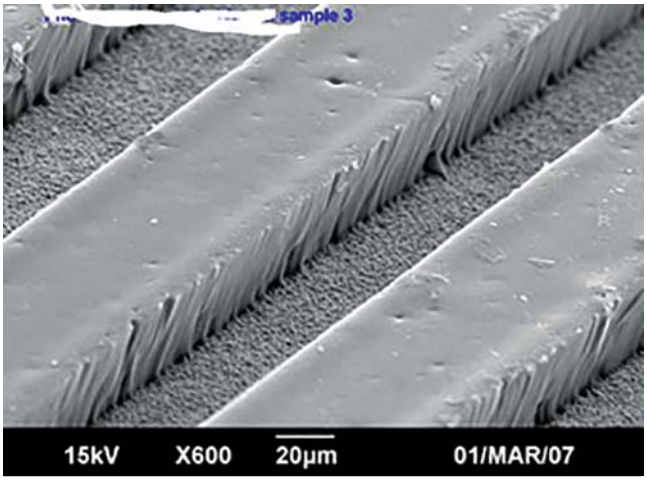


**Figure 1-1**

| CAUSE | ACTION |
|---|---|
| UV source inadequate | Check exposure intensity/wavelength/duration |
| Expose intensity inadequate | Review, reinstated exposure control procedures |
| Expose time inadequate | Review, reinstated exposure control procedures |
| Oxygen exposure of photoresist prior to exposure | Review photoresist shelf life |
| **Potential test methods (discover)** | **Potential test method (verification)** |
| AOI (line/space reproduction)<br>Etch-outs | AOI<br>Periodic UV photometer and step tablet exposure checks |

**1.2 Guidelines for Effective Troubleshooting and Process Control** One of the keys to effective problem solving is a structured routine that addresses key points each time a major problem is encountered. This section suggests steps to effectively find the cause of a problem and to solve it permanently. Refer to IPC-9191 for suggested methodology for statistical process control (SPC).

1. Before beginning a detailed troubleshooting project, use common sense in defining the problem.
   - Verify there is a problem.
   - Observe the defective product and compare it to the standard.
   - Identify the standard process and product, and then determine any present deviation from the standard or any change in the product.

2. Establish whether operating procedures were followed and whether an assignable cause can be quickly identified as the reason behind the problem.
   - Only continue into more detailed analysis if the initial questions do not lead to an obvious answer.
   - Even if the answer appears to be obvious, confirm the answer by operation of the process before closing the project.
3. Develop a clear, concise problem statement that quantifies the problem whenever possible and reduces the scope of the investigation to a manageable size.
4. Gather all pertinent data and facts.
   - Use SPC, historical data, records, logs, etc.
   - This includes temperature charts, analysis records, maintenance logs, etc.
5. Perform a causal analysis:
   - Producing out-of-specification parts requires immediate action (i.e., shut down the process).
   - Out-of-control processes require determination whether the process can continue to operate.
   - Severe process variation requires evaluation of the severity and effect of the problem on the final product.
6. Develop an action plan which includes the procedures for addressing products produced during out-of-specification or out-of-control conditions. The plan should also indicate who should make those decisions. These issues include but are not limited to:
   - Disposition of the defective material (repair, scrap, replace, etc.).
   - Checking the effect on scheduled delivery.
   - Informing the effect on scheduled delivery.
   - Request for nonconformance authority or Material Review Board (MRB) action.
   - Establish a corrective action plan to reduce or eliminate the likelihood of recurrence.
7. Conduct a Measurement System Evaluation, which is a means used to detect and identify the problem. This includes not only the measuring apparatus, but also:
   - The sampling method.
   - The operator (and his/her instructions).
   - Accuracy and calibration of equipment.
   - Environmental factors (e.g., lighting, temperature, and relative humidity (RH))
8. The variation inherent in the measurement of attribute data and responses that are subjective in nature can be addressed. The evaluation is more complex in nature, but it is still an essential part of the analysis of the problem. IPC-9191 discusses this subject in greater detail.

**1.3 Parameter Analysis** The purpose of parameter analysis, as detailed in IPC-9191, is to establish cause-effect relationships and to identify, isolate and rank major sources of variation. Common sources are:

- Positional variation (within a piece).
- Cyclical variation (piece to piece).
- Temporal variation (over time).

**1.3.1 Brainstorming** The development of a cause-and-effect diagram by a cross-functional problem-solving team is critical to the identification of variables to be studied. Care should be taken to include representatives of the disciplines that are part of the process being studied, such as engineering, quality, manufacturing operators, analysis laboratory, etc.

Identify all possible causes of the problem, including process steps, raw materials, materials handling, inspection and personnel (i.e., ‘‘fishbone’’ diagram for root cause analysis). The ranking of these factors by the problem-solving team should be used to establish those factors that will be studied experimentally. The problem-solving team should, at a minimum, include manufacturing engineers, quality engineering and operators who are intimate with the process. The team should take care to openly consider new ideas on the problem.

Situations may occur in which the formation of a brainstorming team is inappropriate. Only someone with troubleshooting experience should make the decision to approach a problem alone. Considerable time and effort can be wasted by failure to get input from all knowledgeable sources.