Cleaning Up the SMT Production Environment

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How clean is your SMT production environment? You may think it is clean, but you would be surprised at the levels of contamination present that can impact production yields and wastage levels. Before you can control contamination, you must be able to measure it and identify the sources. This article examines proven methods for measuring contamination and looks at ways in which the SMT sector is tackling the problem.

In the majority of cases, SMT production takes place in an enclosed area which is not a cleanroom environment. This means there is scope for contamination to enter the production area, leading to unacceptable levels of defects and rework.

To get to the source of the problem, conducting a detailed contamination audit of the production area is essential. Potential sources of particles include hair, lint from cleaning cloths, fibers from clothing, dust, skin flakes, epoxy dust, solder paste, solder resist, and packaging materials. If these particulates are present on the substrate during processing, they may cause any number of defects leading to wastage and disruption to production.

The Contamination Matrix
Using air sampling monitors, it is possible to count the number of particulates in the air. However, this technique fails to tell you what types of contamination are present and it cannot measure particles that are too heavy or large to be airborne.

Normal air monitors can clog up quickly when used in a production environment. Therefore, a special device called a tyndleometer is used to assess the air quality in the production area and provide qualitative data for the number of particles in the air. The tyndleometer collects samples very rapidly so real-time analysis of the air quality in various parts of the room can be conducted. Locations where the samples are taken should be marked on the departmental plan.

Particulates that are too heavy to be airborne are collected using a special handheld roller, which can pick up loose surface contamination. Once the roller is passed over the surface, the particles are transferred onto a special adhesive pad which has a grid pattern on it – this concentrates and holds the contamination for analysis. The pad is overlaid with a release sheet which has details of the precise location of the sample. On this sheet one should make any notes about the sample area, such as whether paint is peeling off equipment.

A contamination audit technique has been developed to provide accurate contamination data. The roller used has a specially formulated elastomer roller, which can pick up particles down to 1-µm in size from any surface in the production area. The particulates then are transferred to a special adhesive pad with a grid pattern on it, as described above. From these results it is possible to construct two types of contamination matrices — a departmental contamination matrix and a facility contamination matrix.

The departmental matrix involves taking samples as above for the department and logging them. Analysis of the samples can reveal immediately where house-keeping or manufacturing procedures and protocols need to be addressed. It also highlights the main types of contamination present.

A facility matrix shows all the departments with their respective contamination levels logged and identifies the flow of contamination throughout the production plant. Analysis of the matrices —which can be color-coded to make them easier to read — can highlight the main areas of contamination that potentially will affect yields. Appropriate action then can be taken to combat the contamination.

Once remedial action is taken, the exercise should be repeated in exactly the same areas to measure how much contamination has been removed. Production levels also should be monitored closely to measure the effect that contamination removal has on yields. The revised matrix should be overlaid on the original one to show the improvements made.

Contamination Audit Methodology
To conduct a contamination audit one must establish the process flow through the facility. Processes can be split into two types from a contamination point of view. The first generate contamination as an inherent part of the process, e.g., drilling or wet processing. Secondly, there are processes that are sensitive to contamination, such as solder paste printing and resist application and exposure.

Stage two of the audit involves preparing plans for every area to be investigated. The plans should show in detail the layout of the room, positioning of equipment, and all the doors to the area, as well as any other places where material or product enters the production area. A section of the plan should be reserved for notes about the type of clothing the operators are wearing and any other relevant details. The plans are used to pinpoint exactly where samples are taken so that the audit can be repeated in precisely the same manner.

Key Sample Areas
Floors: Samples should be taken both from the entrance and a passageway away from the door. Analysis of the two samples will reveal the type and number of particles being carried into the production area. It also is important to take samples from under conveyors and other handling equipment, as contamination from PCBs will fall to the floor.

Walls: Flaking paint on walls can be a major source of contamination, as can notice boards and whiteboards.

Ceilings: Contamination from ceilings can potentially fall straight onto the product being processed. Tiles made from pressed board can deteriorate over time and these particles find their way into the production line. Also, inlet and outlet filters for the air supply frequently are located in the ceiling. This can cause a buildup of contamination that may suddenly fall into the areas below.

Production Equipment: It often is assumed that, as SMT production equipment is enclosed, these machines do not require cleaning. However, samples should be taken of the interior surfaces of the equipment to assess how much contamination could be redistributed onto the substrate by moving parts or forced airflow for cooling.

Product: The boards themselves can be a prime source of contamination. Samples should be taken from the sides and faces of boards immediately prior to being put through any sensitive process such as dry film lamination, exposure, or AOI. The presence of copper or epoxy particles or other process-generated contamination could indicate a need for the process procedures to be evaluated. However, other types of contamination must have come from the production environment.

Transport systems: The totes, carriers, trolleys, and carts used to transport product around the facility can be a source of contamination and therefore must be sampled.

Operators: Even in a controlled environment, people are a key source of contamination. Samples should be taken from the backs and legs of operators for analysis. If cleanroom coats are worn and the legs are still exposed this can be a source of contamination.

Sample Analysis

A microscope (with variable magnification up to 60×) should be used to inspect each square in the sample grid. The different types of contamination can be identified from reference photographs and the number of each kind should be logged in the departmental matrix. Any unusual or unidentifiable particles should be photographed for further investigation and also entered into the contamination matrix.

Contamination Defects

Contamination in the SMT process can lead to the following serious problems:

- Blocked stencil holes which can cause incomplete printing;

- solder paste can become contaminated during reflow leading to volatilization, causing a crater to form in the solder;

- tombstoning can occur where only one end of the chip component is attached to the board and the other end stands on end;

- pieces of fiber from cloths used to clean stencils can become trapped between pads, which may cause short-circuiting;

- poor solder wetting;

- and unreliable solder joints.

Traditionally, printing stencils have been wiped with a cloth and solvent to remove contamination. However, small fibers can become detached from the cloth and attach themselves to the boards, leading to defects and downtime. Also, solder fumes within the SMT line can carry airborne particles. These particles vary in size from 0.01 to 1,000 µm. Therefore, if the pitch of a given component lead is 20 µm, this size of particle can lead to problems.

Contamination Solutions

Fortunately, there are a number of practical steps that can be taken to minimize the impact of contamination. A key solution is to clean PCBs before they enter the production line. As most SMT companies buy in boards from a third party, they have no guarantee that the boards are clean upon arrival at the production site. It is therefore advisable to use contact cleaning equipment to clean the boards immediately, before they enter the line. These cleaners work by using specially formulated elastomer rollers to remove loose particulates from the substrate. These particles are then transferred to an adhesive roll for examination and disposal, similar to the process used in testing facility contamination. Such equipment usually incorporates antistatic facilities to prevent the boards from re-attracting particles. One must be careful in choosing such equipment as inferior rollers will fail to pick up particulates, contributing to downtime, waste, and reduced yield.

There are other actions to take:

- establish strict housekeeping procedures to ensure residual levels of contamination are kept to a minimum;

- filter the air supply to the production line;

• include routine cleaning of the inside of machines as part of scheduled maintenance programs.

Conclusion

Through implementing a proactive and systematic approach to contamination control, it is possible to eliminate defects, reduce wastage, increase production yields, and ultimately maximize the profitability of your SMT line. Contamination matrices are available to help you gather data on contamination with accuracy and repeatability built-in.

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