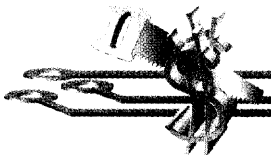

Dissecting Film Defects

Controlling the facility, the process, and the personnel are the keys.

William J. Soules

A clean photoplotter and contact-printer environment is critical to overall imaging cleanliness, but the cost restrictions associated with a full-scale cleanroom often cause board fabricators to postpone upgrades in this area.

The prevalence of 6- to 10-mil lines and spaces and the acceptance of the practice of phototool touch-up have rendered the cleanliness levels of the past satisfactory. Despite the added cost, extensive cleaning of phototools and printers before each exposure has become standard operating procedure.

But the current trend toward decreasing line and space widths, increasing density, and the preference for first-generation phototools that need only minimal inspection and zero touch-up have altered the requirements. As a result, manufacturers of phototool films and chemicals have begun to provide product and packaging compatible with cleanroom environments. But these improvements are of little value if the film is contaminated by the plotter room environment or procedures.

The Elements of Cleanliness

There are three primary areas of concern for fabricators attempting to improve the cleanliness of their imaging process: the facility, the process itself, and the personnel. If one of these three elements slips out of control, it's highly likely that a contaminated phototool or board will result.

Facility

This refers to the environment in which imaging takes place. The cleanliness of the plotter and printer rooms is determined by the ventilation system; the materials that form the walls, floor, and ceiling; the process materials used in the room; the activities that occur in the room; and housekeeping practices. The ventilation system includes the air filtration, HVAC coils, airflow patterns, and number of air changes per hour.

The first step is to address product flow and unidirectional airflow considerations as they pertain to the printing room. These include not only the plotter, but also the laminator, board cleaner, and carts loaded with boards waiting to be exposed. In some cases, achieving unidirectional airflow may be as simple as placing a self-powered fan/filter unit over the operation. Equipment manufacturers should also consider product upgrades with this objective in mind.

The second step that may be required to improve cleanliness is the installation of a cleanroom with a specific classification (e. g., Class 10,000). This will enhance the environment but can be very expensive and, depending on its design and the way it's used, may not even yield cleaner images! In an improperly constructed cleanroom, air filtration efficiency is low, air is supplied and returned at the ceiling, air change rate is low, and construction materials generate particles. A portable cleanroom placed over a specific operational area can be a more economical use of unidirectional (laminar) airflow. A thorough study of the process should be conducted before the decision is made to construct any type of cleanroom. We'll go into more detail on the subject of processes a little later.

In laying out a plotter room to accommodate a portable cleanroom, the path of the film's movement throughout the room should be kept as short as possible. The smaller the cleanroom, the better.

Process

The process involves all the equipment, materials, and procedures used to generate the image. In the area of equipment, photoplotter design and cleanliness are

crucial. Again, system manufacturers have the opportunity to upgrade their designs to further this goal.

It's also recommended that a film conditioning cabinet be used, which isolates the material from the environment while using a fan to circulate air past the product. When such a system is implemented, the film's exposure to the environment for equilibration purposes is limited to the amount of time it takes the technician to load and unload the cabinet. The cabinet should have HEPA filters behind the fan to remove all particles from the air passing over the film.

The materials and procedures involved in the imaging process are closely intertwined. Phototool film should be shipped in a light-tight package sealed in a plastic bag, which, in turn, should be placed inside a film box. The film is first removed from the pack for equilibration with ambient temperature/humidity conditions. This helps to ensure good dimensional stability, which is increasingly important considering today's number of layers and increasing board sizes.

Next, the film is placed in the plotter. Flatbed machines involve considerable film exposure and risk, but these can be mitigated by the presence of a portable cleanroom over the plotter and use of the appropriate cleanroom garments. With a cartridge plotter, the risk arises during the cartridge loading phase.

Finally, when the film is being taken from the plotter to the processor, the risk is at its lowest point since the image has already been plotted. It's still beneficial, however, to optimize processing solution cleanliness by keeping the film/processor feed tray isolated from the plotter room environment via a portable cleanroom, and to wear proper cleanroom attire.

A basic procedural element that cannot be overemphasized is housekeeping. All surfaces, including the interior of film cartridges, plotters, processors, laminators, and printers, must be cleaned using the proper materials. Though unidirectional airflow helps to reduce particulate buildup, the need for housekeeping will never be eliminated.

Implementing an effective cleaning policy isn't enough; all surfaces should be inspected to verify that they've been cleaned. The use of black or high-intensity white light is the most effective technique. Under such illumination sources, particles as small as 25 microns (1 roil) can be seen. A good rule of thumb regarding particles is this: If you can see it, it should be considered a potential problem in the imaging operation.

Personnel

Since it has been reported that people are the greatest source of particles and fibers in a cleanroom, they must be properly garmented and use good film-handling practices. The technician who loads and unloads the film should wear a 100%-polyester cleanroom garment made of low-linting material. Proper wearing, storage, and laundering are also critical. The suggested cleanroom garment is a frock with knit cuffs and a zippered front. A full head cover is also recommended for those working in a unidirectional-airflow environment.

A final consideration is personnel training that includes instruction in the basics of contamination control, possible sources of contamination to the phototool and the board, and the impact of the employee's work on the quality of the phototool or the board.

Conclusion

When the facility, the process, and the personnel are in control, the imaging problems resulting from airborne contamination are greatly reduced. The good news is that an expensive cleanroom configuration is not essential to achieving high-yield imaging of today's complex designs. FAB

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