

The Cause and Elimination of White Residue

The unexpected appearance of a spotty, non-uniform deposit on the surface of a printed circuit called white residue - is most often experienced after fluxing, soldering and cleaning. The make-up of deposits can vary widely. They can consist of flux, metal oxides, flux activators, solder, or many other things.

While the phenomenon is unpredictable, it can be eliminated by a two-step process. The first step is to identify the cause from among five likely source groups. The second step involves carrying out appropriate action to further define and eliminate the problem.

How to Identify the Cause:

1. Substrate and Components

Take an identical unpopulated board from the problem lot and preclean it by processing it through the normal defluxing sequence. Then flux, preheat, solder and deflux under the same conditions that produced the residue. Compare results. Elimination of the residue suggests a problem with a board substrate and/or component contamination. Check for adequate cure of the board laminate. Precleaning the substrate and components may be necessary to eliminate the residue formation. There also could be a problem with component holding waxes. If residue persists, proceed with Step 2.

2. Flux

Using an unpopulated board from the same lot, omit contact with flux but preheat, solder and process through the defluxer. If no residue develops, the flux and soldering steps are suspect.

3. Solder

Repeat Step 2, but deflux and preheat, skip the solder wave, but deflux normally. Lack of residue makes the solder temperature and extended contact time suspect for the flux used. See recommendations 1, 2, and 3.

4. Defluxing

Follow the normal procedure using a populated board but delay the entrance of the freshly soldered board into the defluxer until the board temperature has cooled to nearly ambient temperature ($\approx 85^{\circ}\text{F}$). Deflux normally and observe whether a residue has developed. If no residue appears, then the original board may have been too hot, causing the defluxing fluid to flash off and create a deposit. See recommendation #4.

5. *Miscellaneous*

Apparent residue from other sources, such as damage to incompletely cured substrate or masked surfaces may be found by inspecting the variously treated surfaces under optical magnification. For example, the damage may appear on the unfluxed solder-wave heated surface but not on the fluxed but unsoldered board. Use magnification to test and identify residues for solubility in drops of water or alcohol. The residue is most likely inorganic in nature if it dissolves in water. If it dissolves in alcohol but not water, the rosin or other organic acids are the more likely sources.

How to Eliminate the Problem

1. Most "white residue" cases are due to chemical changes in the rosin or water-soluble acid components of the flux. This makes them less soluble in the defluxing fluid than the original compounds. Reaction of these organic acids with tin and lead and their oxides form insoluble heavy metal soap compounds. Both of these residue-forming reactions occur more rapidly as the temperature increases, and continue as long as the elevated temperature is maintained. Therefore, reduce the solder temperature and length of time in the solder wave to the minimum values consistent with good soldering.
2. Use the manufacturer's recommended flux for your particular board. Follow instructions for proper composition (solids level) control, replenishment, replacement and fluxer maintenance. Also, preheat the fluxed boards as recommended, taking the approach outlined in Step 1 to prevent overheating.
3. Maintain a high purity solder bath, checked by periodic analysis, and remove dross regularly. If soldering oil is used, change it regularly as recommended by the manufacturer.
4. Maintain the composition of the defluxing fluid and proper operating conditions of the equipment. Do not deflux boards that are hotter than the defluxing medium is upon first contact (liquid or vapor). Boards should be defluxed shortly after they reach ambient temperature, since all fluxes become more resistant to removal upon aging after soldering.
5. Defects in substrate surfaces should be referred to the board vendor.