Selective Soldering Process Development Aided by Solderability Testing

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ACE Production Technologies' Selective Soldering Applications Lab recently processed a group of samples for a customer - and in the parts mix was a component that had oxidized leads. During development of the process, the operator found that no matter which flux was selected, or which profile was used, the solder would not wet to the part. Process development for the application was stalled until this problem could be solved.

The ACE Process Development Lab initially processed the customer's sample assemblies using the KISS-103 selective soldering system.

We used a 4.5mm soldering nozzle, the customer-provided 2009M no-clean flux, and Alpha SAC 305 lead-free solder. The 4.5mm nozzle was chosen for its inherent precision, and it also provided the width needed to solder the pins in the least number of passes. This nozzle also provided an ample amount of thermal energy to heat the parts, allowing solder to flow for a minimal dwell time. Flux application was done with a drop-jet fluxer, which is ideal for applying a precise amount of flux to a specific location, thereby reducing overspray and providing a cleaner finish.

After processing the first board, X-ray images were taken of the barrel fill (**Figure 1**) that looked good for a first attempt, and were assumed easy enough to correct where needed. There were also indications that some adjustments might be needed in order to achieve a proper bottom-side solder shape. We made some adjustments to the flux application, as the shapes led us to believe there was a lack of flux getting to the pins which caused a couple of bridges and "flagging", and ran the same board with these adjustments made, and the bottom-side result was much improved.

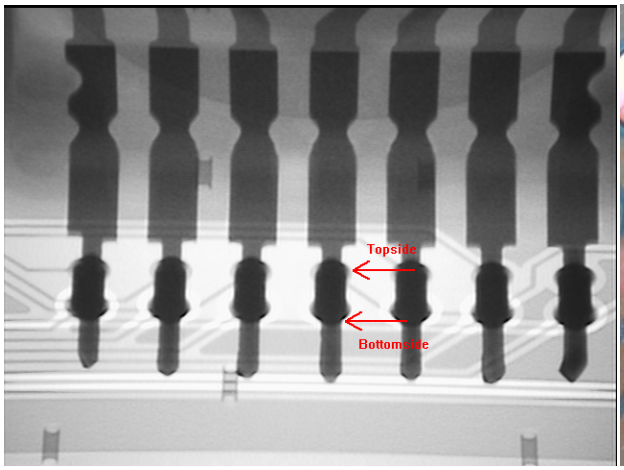

Figure 1: X-ray after first attempt

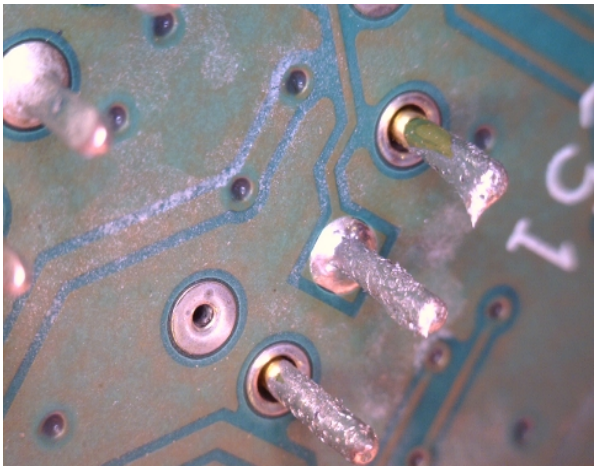

Figure 2: Pins showing non-wetting

We then proceeded to the second board using the same program. This process run delivered a nearly identical result to that of the first, showing good barrel fill, but with bottom-side shapes that were undesirable. **Figure 2** shows examples of pins resisting the solder wave almost completely. Only when the wave was able to contact the pad itself did any soldering take place. Based on the X-ray of the

switches (**Figure 3**) which shows voided areas, and significantly, "spotted" areas of the pin where the solder did not adhere, it was concluded that there was a contamination problem. Additionally, we questioned whether or not there was any intermetallic bond created between the solder and the pin.

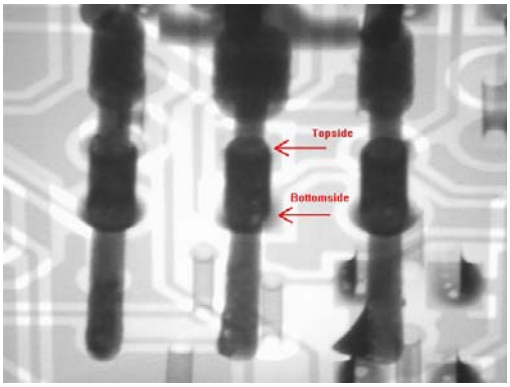

Figure 3: X-ray void and poor pin solder acceptance

After a couple of additional attempts to correct the remaining bottom-side pins, a wetting balance (solderability) test was performed. The tester used was a MUST III System, a wetting balance testing system capable of testing to all relevant solder standards including ICE, MIL-STD, IPO/EYE/JADE, etc. The MUST System 3 measures the solderability of a printed circuit board and/or component's metallic terminations by documenting the wetting curve of the unit under test. The MUST III is appropriate for testing all devices including multi-leaded components as well as SMT and BGA devices.

Nine (9) of the pins were tested, and the results recorded (graph, **Figure 4**). No flux was used for the first pin, in order to provide a 'worst case' scenario. Then the remaining eight (8) pins were processed using the same flux that was provided for processing the sample boards. As may be seen, most of the pins did not recover beyond the 'zero point' or 'buoyancy' level, which is the point where the pin stops resisting the solder and begins to be drawn into it. **Figure 5** shows the graph of another set of tests conducted with the exact same parameters and pins from another sample part in the lab's inventory (not one of this customer's samples). As may be seen, there is a significant drop in initial solder rejection, as well as attaining "maximum" acceptance within .5 second. We then re-tested the four weakest results (**Figure 6**) from the first graph, which proved that the newly-tinned pin accepted solder much better, closer to what it should, thus proving that the plating condition was responsible for the bottom-side shape problems.

For the final run, all of the leads were trimmed to approximately 1mm; the intent was to see if the solder might 'overwhelm' the oxidized plating and provide an acceptable result, but it was not sufficient to offset the problem. We also concluded that at no point was the barrel plating material an issue, since even from the first run we had no trouble getting full visible topside.

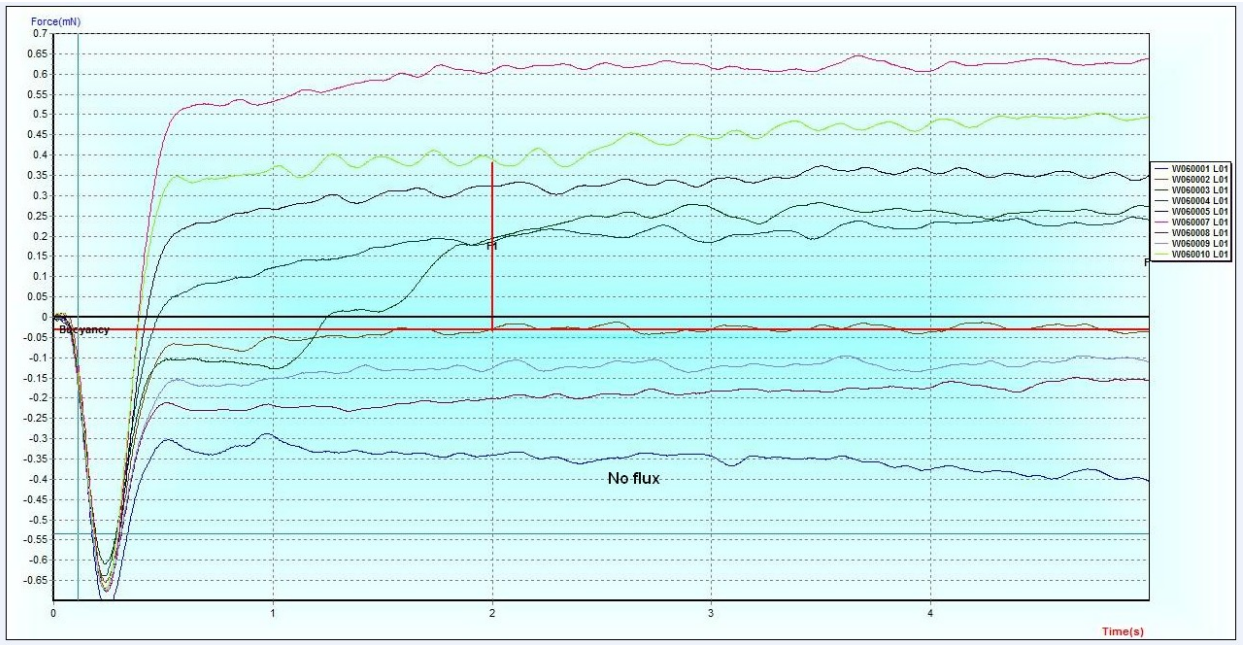

Figure 4: Initial part testing of nine (9) pins

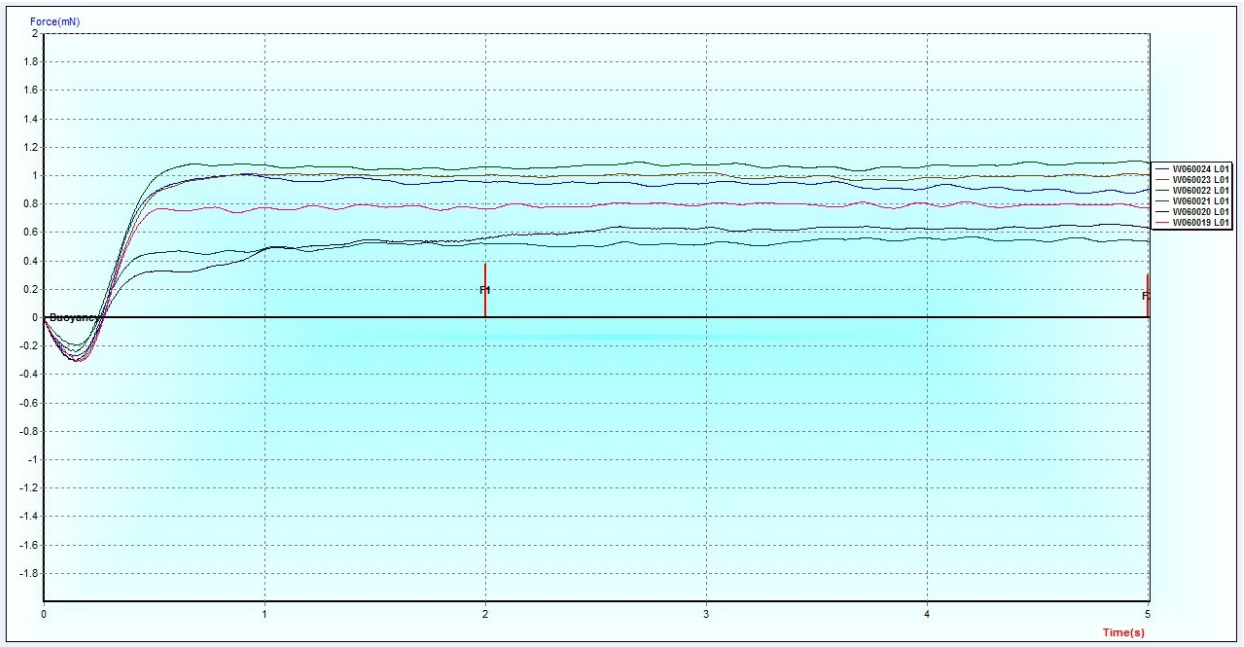

Figure 5: Testing of similar pins with identical parameters

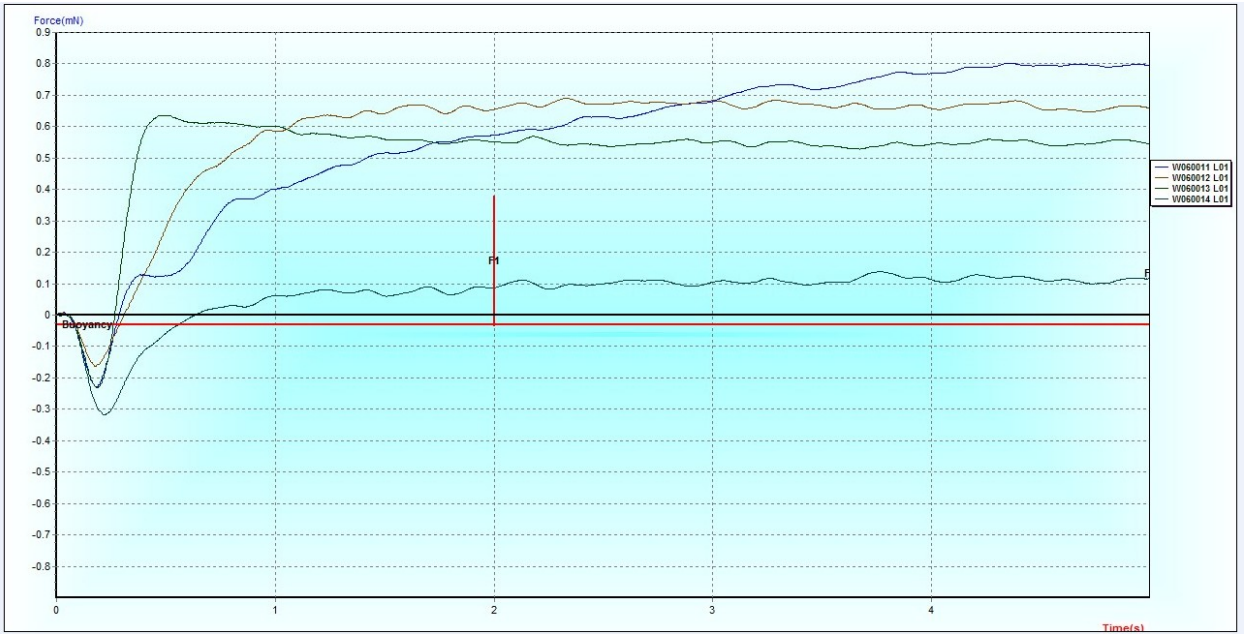

Figure 6: Retest of four (4) weakest pins

Conclusion

Soldering defects due to non-wetting have a variety of causes, and those causes must be identified and their root problems solved in order to realize the benefits of automated production and to achieve high yields with steady repeatability. Solderability issues regardless of the source (e.g., plating) can be identified, tracked, and solved with good solderability testing and the selective or other soldering process then optimized.

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