Realizing the Benefits of 3D Inline Solder Paste Inspection

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Abstract

Despite the numerous publications and examples available in the public domain showing the various benefits of doing 3D solder paste inspection (SPI) to control print processes, eliminate and/or identify solder paste printing errors, some companies still question the benefit. Most companies and people agree that an inspection plan of some sort is a must but automated 3D inspection plans are not necessarily mainstream. A recent study conducted on the industry position on the 2D vs. 3D question shows that 3D is preferred and even required in 4 out of 5 cases [1]. This article provides some examples of the recent successes that SMT (surface mount technology) assembly is realizing from 3D solder paste inspection and verifies the continual trend towards 100% 3D inline SPI.

Introduction

It is an established fact that many defects are attributed to the solder paste printing process [1,2,3,4,5,6,7,8]. Some publications and companies claim this number to be as high as 80% of their overall defect pareto! It is also a known fact that solder paste volume is an important predictor of good quality solder joints and long-term reliability of solder joints [1,3,9,10,11]. Use of 100% solder paste inspection (SPI) helps reduce the contributions from the print process to solder joint defects [12], in-turn saving money by reducing the cost of scrap with minimal cost to rework (i.e. wash boards) and with no penalty in solder joint reliability [3]. Calculations have shown that pre-reflow print failure can cost 10X less than the post reflow, 70X less than in-circuit test, 700X less than a field failure [2, 3]. With new technologies in solder paste inspection available, process control in conjunction with solder paste printing and 3D pre-reflow paste inspection is imperative. Inline process control is an opportunity to increase reliability and save money.

Countless publications and examples of the information illustrated earlier in this article are available showing the various benefits of doing 2D and/or 3D solder paste inspection to control print processes and eliminate or identify paste printing errors. Most companies and people agree that an inspection plan of some sort is a must in today's manufacturing arena with challenging chip scale packages (CSP's) and devices down to 0201's. Why then are many companies utilizing no solder paste inspection, 2D paste inspection or 2D with 3D sampling for solder paste measurements? There are many reasons for this, including the unfortunate economic climate where replacing or adding capital equipment is not favorable. Despite these reasons, new technological advancements in the past few years have made 3D SPI at line rates a reality and many companies have made the investment in 3D SPI. Those companies are finding benefit, are producing high reliability parts and are saving more money than they spent on the inspection equipment.

Process control has become a key element in the success of finer pitch devices, like 0201's, CSP's, BGA's (ball grid array), CCGA's (ceramic column grid array) which have known requirements for volume [13,14]. The ability to tightly control each assembly process to ensure high yields has given assembly houses a definite advantage in the market place.

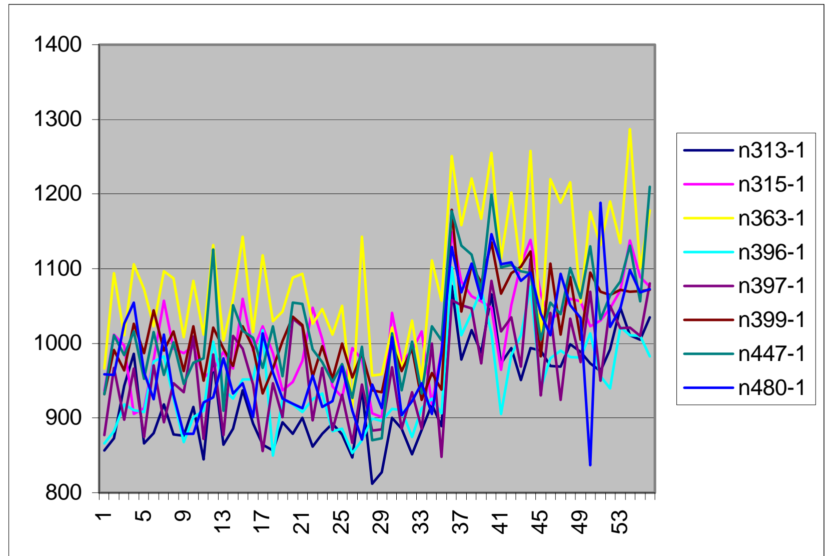
Results

Recent work done with 100% 3D inline solder paste inspection customers has shown the SPI and process control benefit. The examples illustrated herein utilized an Agilent SP50 for the solder paste inspection data. The Agilent SP50 is a 100% inline 2D and 3D SPI system. This system utilizes a proprietary imaging chain thus providing a 20um/pixel resolution all the time with high speeds competitive with production lines, thus giving users 2D and 3D paste information without a compromise in resolution or speed.

In one assembly house, a product quality issue with BGA's was identified with the Agilent 5DX X-ray inspection system. The BGA results were analyzed. When the results were studied, volume of the paste that was printed on these BGA's was discovered to be higher at the same time on the day where the quality issues surfaced (Figure 1). Therefore, a fine tune of the SPI program to catch this volume increase can

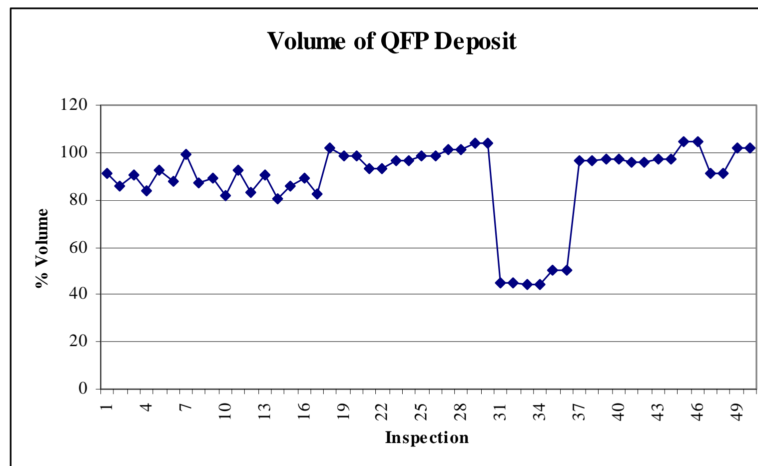
catch these defects upstream and prevent them. Catching the defect early can save on rework costs. Additionally, knowing the volume of paste and controlling it can contribute to favorable long-term joint reliability [3, 9, 10, 11].

Figure 1 – BGA Quality Issue



A second assembly house found that a change in volume had occurred on a QFP (quad flat pack) according to SPI inspection results (Figure 2). The deposit has a 50% volume reduction for 6 consecutive PCB's (printed circuit board). The 3D solder paste inspection system identified the problem. Screen printing adjustments were made and the process came back in control. It is noteworthy that had only 2D inspection been utilized this issue would not have been realized (i.e. 2D inspection cannot detect volume information).

Figure 2: QFP Volume Flagged



Another example of an SPI defect call is found in Figure 3. A bad print was flagged for area, height and volume errors (Figure 3A). The errors are evident by eye once identified with the SPI system and examined closely in the magnified view of the issue, as seen in the enlarged photo of the actual pasted pads (Figure 3A). In this case, the print speed had been incorrectly modified on the screen printer and was creating poorly pasted boards. When the print speed was returned to the normal setting, the print returns to a good print (visible by eye and no error flag from SPI, Figure 3B).

3A **3B**

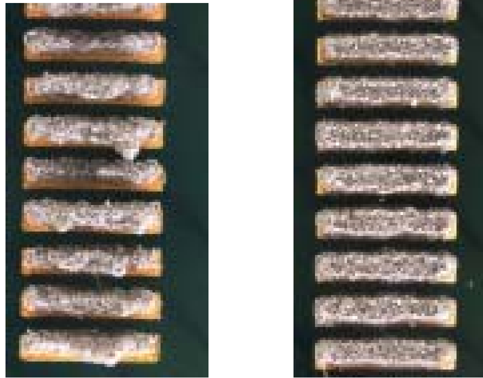


Figure 3: Incorrectly programmed screen printer parameters cause errors.

Conclusion

Countless examples similar to these can be found in production lines around the globe. Examples from different assembly houses, on the value add that 3D SPI has given them re-emphasizes the need for 3D SPI. Even if just one defect is saved from your end user's hands, your return on investment for 3D SPI will be justifiable in a short period of time. Additionally, the savings associated with a reputation for shipping parts with exemplary long-term reliability is not measurable. In general inspecting 2D and 3D is essential to avoid sending poorly printed devices downstream or compromising the long-term reliability of devices being built. Today's 3D SPI offerings allow customers to cut costs through process improvement and defect detection and elimination, thus building profits and providing competitive and robust assembly processes.

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