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Microfocus X-Ray Inspection System

A Soldering Defect Inspection Using the Automatic Measurement System of SMX-1000 Plus

Introduction

Various electronic components are mounted on electronic circuit boards which are indispensable for controlling electronic devices. For an electronic circuit board to operate properly, its electronic components should not have any substantial damage and the components must be appropriately bonded to it. However, defects occur at a certain rate when bonding components to electronic circuit boards. Accordingly, the inspection process serves an important role as it is through this process that defective components and soldering defects are detected and removed from the production process at an early stage and the cause of the defects are identified.

The SMX-1000 Plus microfocus X-ray inspection system (Fig. 1) is useful for such defect inspections of electronic circuit boards and electronic components. Defective components and soldering defects can be detected quickly by X-ray inspections since real-time fluoroscopic images can be obtained without damaging the object that is being inspected.

Furthermore, SMX-1000 Plus features an optional automatic measurement system that can make inspections more efficient. Inspections that conventionally have been performed as visual inspections can be automated by using this option.

This article introduces an example of inspections that are possible using the automatic measurement system of SMX-1000 Plus.

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Fig. 1 SMX-1000 Plus Microfocus X-Ray Inspection System

Solder Bump Observation

Fig. 2 is a fluoroscopic image of a test workpiece with rows of equally spaced solder bumps. Taken with a large field of view, Fig. 2-① enables the operator to check a few hundred solder bumps in one image. Defects such as insufficient amount of solder or bridged bumps can be detected from this fluoroscopic image.

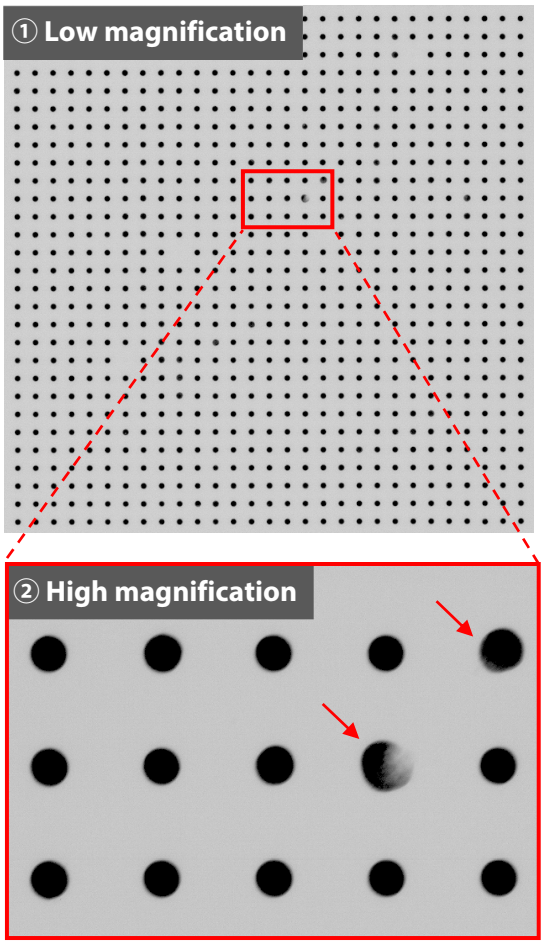


Fig. 2 Fluoroscopic Images of Solder Bumps (Red arrow: Defect)

However, since the bump diameter in the image becomes smaller the larger the field of view is, the operator may not be able to detect small defects by observing this image.

When the observation magnification is increased as with Fig. 2-②, the shape of the bumps can be observed in detail thereby allowing defects of the bumps, such as those shown by red arrows in the image, to be detected easily. High magnification images enable inspections with higher precision since minute defects that may not be detected in low magnification images can be observed in detail. However, increasing the observation magnification results in a limited field of view and more images must be taken and checked in order to inspect the same area that is shown in Fig. 2-①. Such an inspection is time and effort consuming.

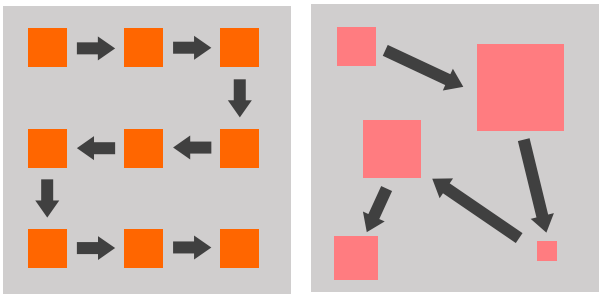


Fig. 3 Image Acquisition Program Function
(Left: Step feed function, Right: Teaching function)

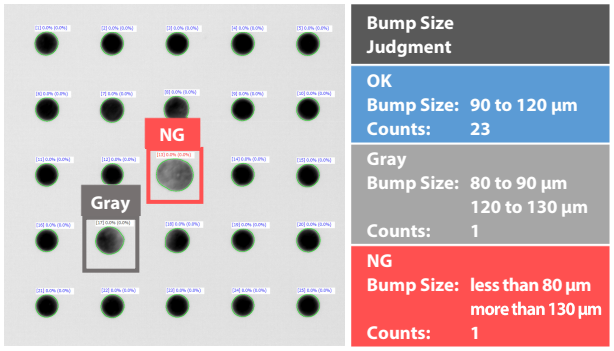


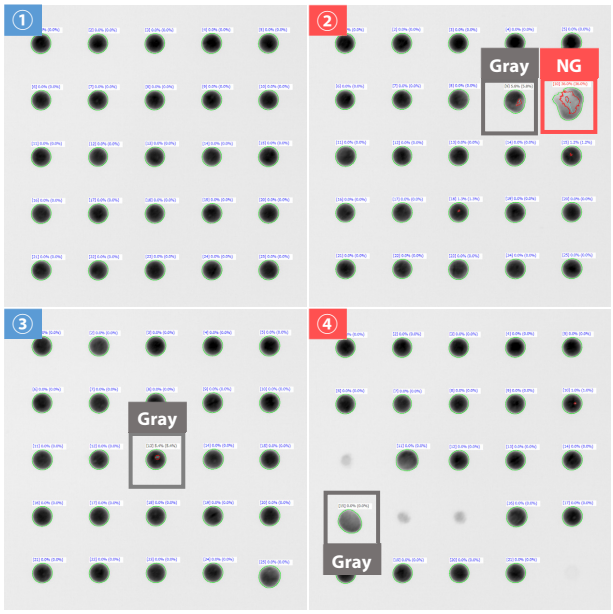
Fig. 4 BGA Measurement: OK/Gray/NG Judgment by Bump Size
(Red frame: bumps judged as NG, Gray frame: bumps judged as Gray, No frame: bumps judged as OK)

Inspections can be performed efficiently by using the following features of SMX-1000 Plus: the image acquisition program functions (step feed function and teaching function) and the automatic measurement system.

Diagrams of the two types of image acquisition program functions are shown in Fig. 3. Image acquisition areas are indicated by the orange and pink squares. The step feed function automatically acquires images at equal intervals and magnification. The teaching function automatically acquires images based on the positions and observation conditions registered by the operator. By combining these functions and the later described automatic measurement system, not only can time and effort required for inspections be reduced but also human errors can be reduced dramatically.

Fig. 4 shows an example of an inspection of the same test workpiece shown in Fig. 2 using the BGA measurement function of the automatic measurement system. Bump diameters are measured by automatically extracting the solder bumps from the image obtained by using the image acquisition program function based on the brightness data (the gray shades in the image).

Furthermore, as shown in Fig. 4, pass (OK)/fail (NG) evaluation can be performed using the measurement results. As a feature of the judgment function of this system, the judgment criteria settings include "Gray" in addition to OK and NG. The Gray criterion can be used for the range that may not be judged correctly by mechanical judgment. The sections judged as Gray can later be checked visually to further enhance the certainty of the inspection. In addition to bump diameters, this system can also measure the total void ratio, the maximum void ratio, and the roundness of each bump.



	Each Bump Judgment	Area Judgment
①	OK: 25	OK
②	OK: 23 Gray: 1 NG: 1	NG
③	OK: 24 Gray: 1	Gray
④	OK: 20 Gray: 1	NG

Fig. 5 BGA Measurement: OK/Gray/NG Judgment by Multiple Criteria
(Red frame: bumps judged as NG, Gray frame: bumps judged as Gray, No frame: bumps judged as OK)

Furthermore, this system enables the operator to perform OK/Gray/NG evaluation not only for individual bumps but also for individual images at the same time. Fig. 5 is an example of such simultaneous evaluations: automatic image acquisition and automatic measurement were performed for four sections of the workpiece. Since all bumps in the field of view of image ① were judged as OK, the image was also judged as OK. The judgment of image ② was NG since one bump was judged as NG and another bump was judged as Gray based on the diameter criterion. As for image ③, one bump was judged as Gray due to a slightly high void ratio and therefore the image was also judged as Gray. Although only one bump in image ④ was judged as Gray based on the bump diameter and the void ratio criteria, the image was judged as NG since the number of bumps extracted was lower than 25. As demonstrated by these examples, this software enables the evaluation of not only individual objects but also the entire image.

Conclusion

Soldering defect inspections for electronic circuit boards can be performed faster and efficiently by using the automatic measurement system of SMX-1000 Plus. In addition to the solder bump inspections introduced in this article, this system can be used for various other samples and inspections.

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