[Development of alignment method for ununiform deformed board by reticle free exposure apparatus – Masahiro Nagano]

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Introduction

There are many compact information equipments in our life (e.g. laptop, smart phone, etc). These are used the FPC (Flexible Printed Circuits). These are used the FPC (Flexible Printed Circuits). FPC is applied to the small size and light weight and high performance of these devices. Polyimide films are known as the base material of the FPC. Polyimide has mechanical properties, flame retardancy, chemical resistance, and excellent properties in electrical characteristics. However, it has a coefficient of thermal expansion of approximately 20ppm / K ~ 50ppm / K. This is greater than the thermal expansion coefficient of 16.5ppm / K of the copper foil that is often used as the material of the conductor portion. Thus, when making the wiring copper foil, non-uniform distortion is generated by difference of the thermal expansion coefficient. After wiring fabricated, must create the contact hole. However, it is difficult to take alignment by the distortion. The amount of distortion of the substrate has a variation. And it is difficult to predict. Therefore it is not possible to create a mask in consideration of the expansion amount in advance, also require a corresponding alignment in the non-uniform stretching.

Proposed Method

Since in the present study corresponds to the non-uniform expansion and contraction, we are using the reticle free exposure device. In this device, use the DMD (Digital Micro Mirror Device) instead of glass reticle.

Prepare any wiring pattern for etching a copper foil FPC (Fig.1). Then, compare the provided wiring pattern and wire distortion on FPC (Fig.2), and detects the feature. This makes it possible to know the distortion amount and direction of the FPC. The distortion amount and direction is applied to the mask pattern for forming contact holes, and perform an alignment against distortion. The flow of the entire system is shown in Fig.3.

Experiment and Result

In developing a nonuniform substrate corresponding alignment method, experiments were conducted by incorporating a correction program in the exposure apparatus. The input of this system, we used the three images. They are arbitrary wiring pattern (1st exposure pattern), wire distortion after etching (Distortion pattern), and exposure pattern of the contact hole (2nd exposure pattern). An example of an input image is shown in Fig.4 (a) ~ (c). Distortion pattern is made by lithography to form a distorted advance on a Si substrate, and is acquired by the CCD camera.

The output of this system is shown in Fig.4 (d). From the figure, it can be seen that it is carried out successfully alignment. Furthermore, in order to evaluate the system quantitatively, we verify correct accuracy and throughput in three types of circuits.

The correction accuracy was verified by calculating output pattern's cover rate and the distance from the center of contact hole. The verification result shown in Fig.5 and Fig.6. From the graph, even when the distortion of the extent nonoverlap originally occurred, it was found that can be corrected with high accuracy. Furthermore, It is found that be able to correct so as to be located more centrally with respect to small distortion. For throughput were compared by measuring the execution time for each processing. A verification result is shown in Fig.7. From Fig.7, it does not affect the complexity of the circuits, it was found that roughly to perform alignment in about 1,400msec whatever circuit.

Conclusion

In this study, we have proposed a Distortion correction system by the reticle free exposure device using a DMD. Then, by calculating the cover ratio and the distance to the target point of the contact holes, it is shown that the alignment is successful.

Further, it was also tested throughput. To measure the execution time for each process and I have shown that operating at sufficiently high speed. From the above, the purpose of developing an alignment system corresponding to the non-uniform expansion and contraction it showed that it was achieved.

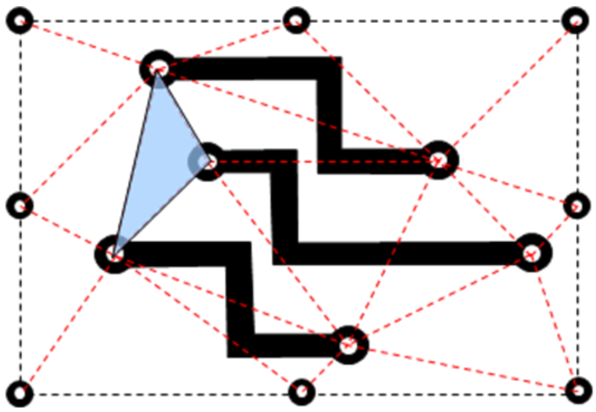

Fig.1: Before the wiring pattern distortion occurs

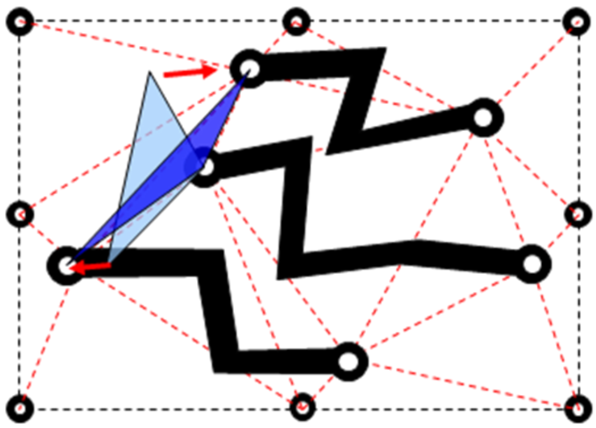

Fig.2: Wiring Distortion after etching

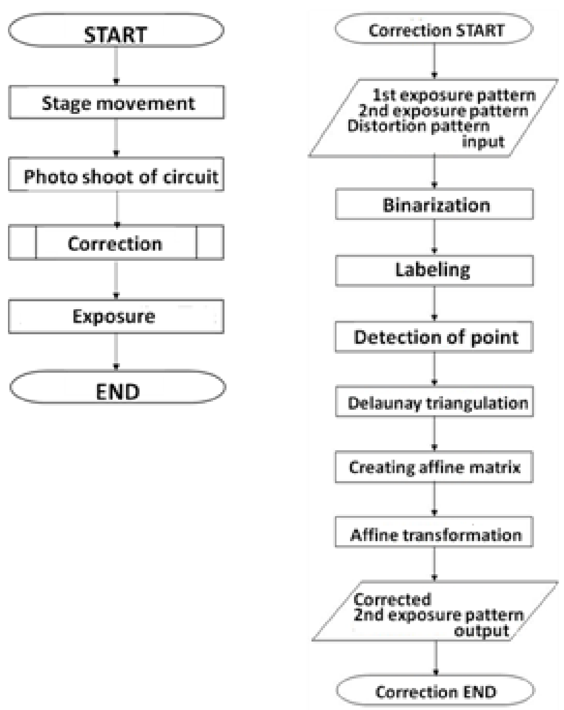

Fig.3: Flowchart of the system

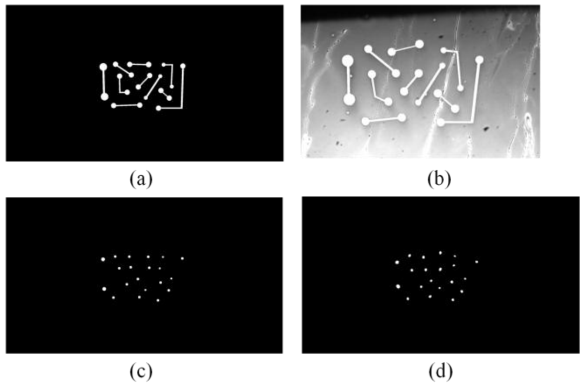

Fig.4: Examples of input and output image

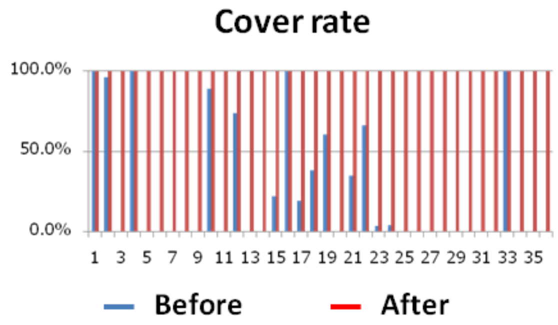

Fig.5:Cover rate

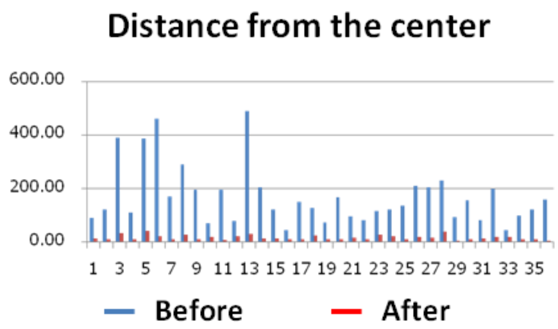

Fig.6: Distance from the center of contact hole

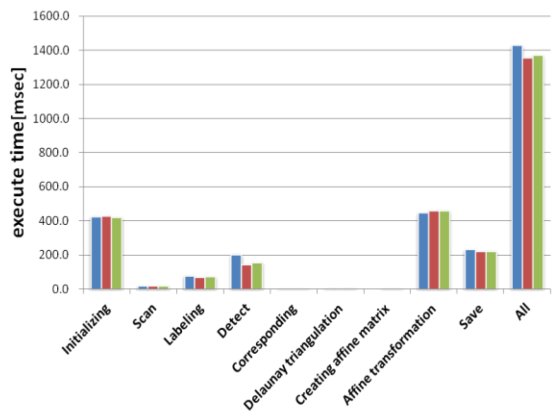

Fig.7: Throughput