Development of Viscous Inspection Equipment by Moire Phenomenon for Flatron Panel Glass

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Abstract

In this study, we describe the development of viscous inspection equipment for flatron panel glass by Moire phenomenon and propose a new idea to develop an automatic inspection system for viscous or cord defects. It is possible to detect string viscous more easily and the equipment is practically being applied in production line. After using this equipment, the ratio of defective from customer is dropped significantly.

1. Introduction

Despite the increased complaints of the customer owing to the increase of the string viscous in flatron panel glass, it was almost impossible to detect this defect in the process of inspection because of the inside stipple. And the development of inspection equipment for this was inevitable in the light of the establishment of applied technology.

Approaching methods in the early stage of development are as follows:

First, unlike common CDT, Flatron has stripe pitch type, second, it is mostly found in the process of Black matrix and ITC on the part of customer, third, the defect aimed at is String viscous. So, we approached with the phenomenon of Moire fringe. Moire means the pattern of wave and Moire fringe is generated by interference of two different kinds of patterns with spatial period overlapped. The generated period is much longer than that of each original pattern and also the velocity is much higher. Therefore, this phenomenon is used in the industry such as minute deflection, rotation, wave interference and recognition of three-dimensional object.[1.3]

Fig.1 shows the displacement amplification effect that happens when two gratings are overlapped. (a) represents the rectilinear grating that has a period of 'p' and (b) does one that has the same period as (a) and which is rotated as much as θ counterclockwise. When two types of pattern having the relative angle for each other overlap, a new pattern with a new period is generated. This new pattern itself is just Moire fringe (c),(d).

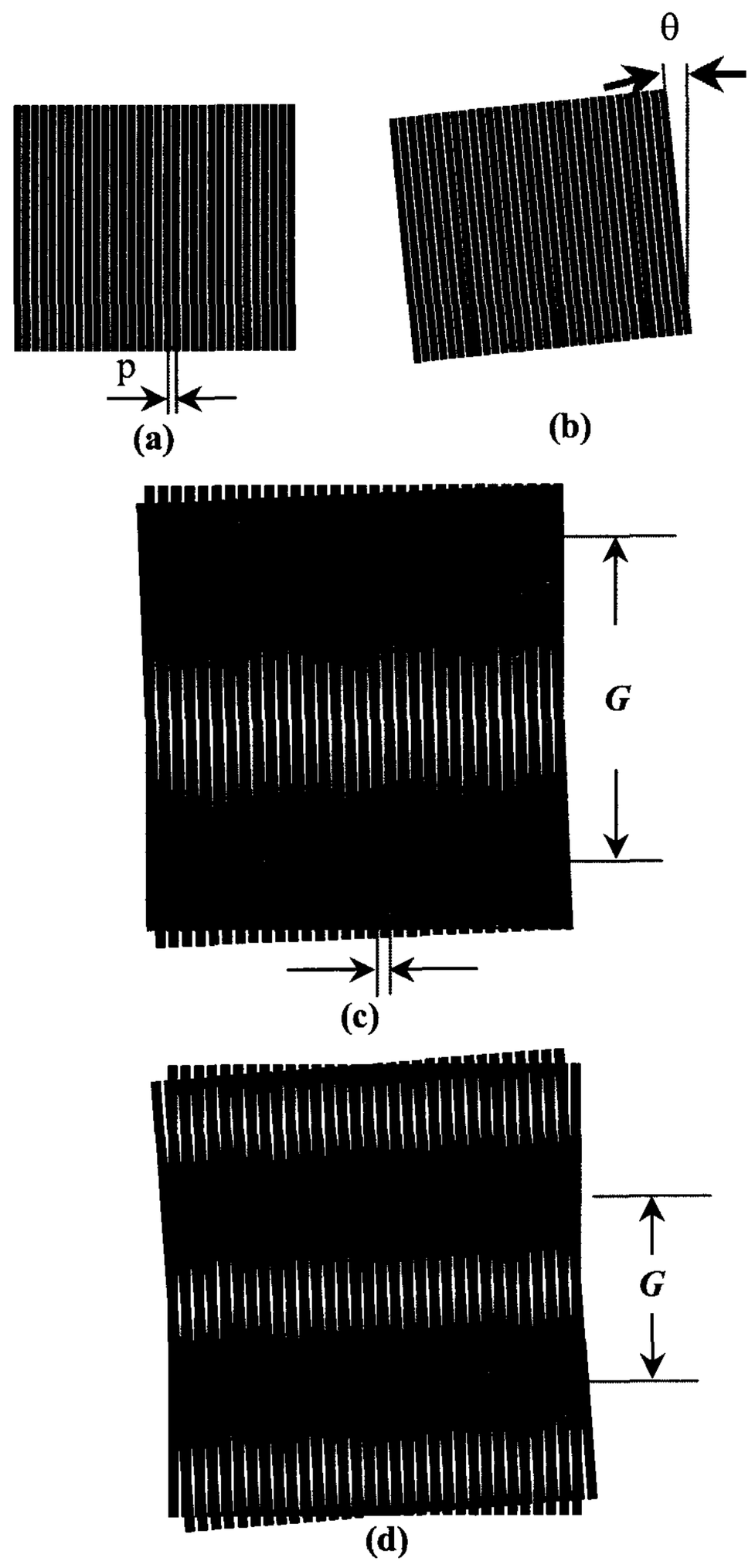


Figure 1. Displacement amplification effect

This generated period of pattern, G, is represented by the following relation equation (1);

$$G=p/2\sin(\theta/2) \qquad (1)$$

The value of period in this pattern depends on the relative angle between the two patterns or gratings when these are overlapped. And the period of Moire fringe is significantly larger than that of grating itself as we can see.[2]

The shape of String viscous appears in the form of linear. When it overlaps with a certain grating image, visibility differs according to its relative angle. Visibility in terms of the angle of String viscous acting as a kind of virtual grating is presented here in Fig.2. As you can see in Fig.2 and Fig.3, when it has a little angle, its visibility is much better than when it is vertical against main grating.

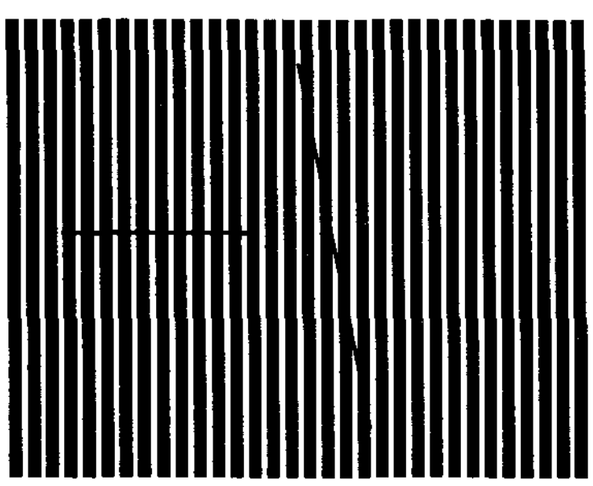


Figure 2. Visibility of string viscous acting as a virtual grating

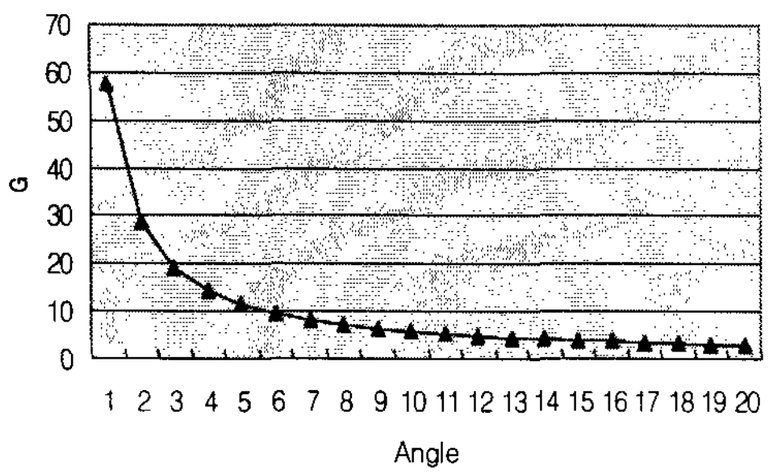


Figure 3. The dependence of G on the relative angle between the two patterns or gratings

Actually, in case you obtain the image of Moire fringe and measure displacement of shape of object with it, increasing visibility is one of the most important processes for decreasing errors and measuring precisely. Generally, Moire fringe has a good visibility when the following conditions are satisfied;

First, when line and space of grating is almost same, for example, Ronchi ruling grating; second, when angle between overlapped two gratings is small, three, a pitch of overlapped two gratings is almost same. As above-mentioned, in case third conditions are satisfied, we will have Moire fringe with high contrast. Particularly, when we have the ration of the grating pitch of 1:1.05 on the third condition, we have Moire fringe having interval of about 20 times of the original grating pitch.

2. Experiment

Fig. 4 represents the image of String viscous which is produced by attaching grating printed film on the surface below.

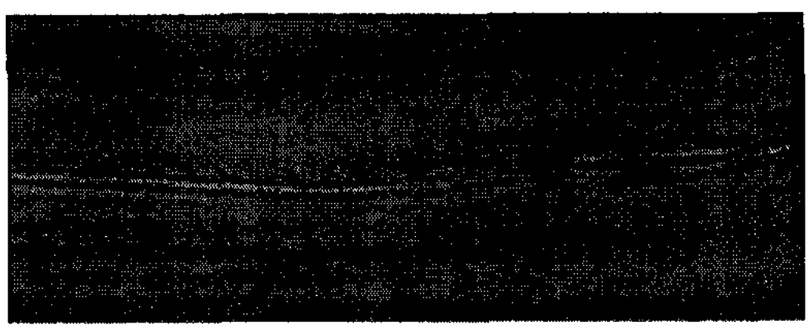


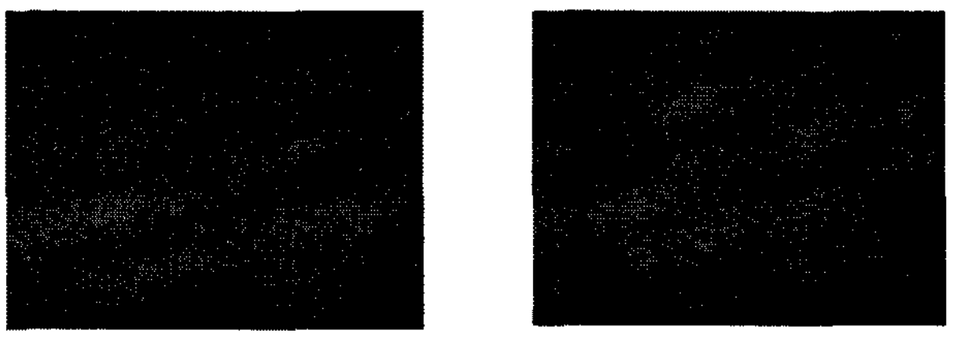
Figure 4. String viscous produced by attaching grating printed film

Although, generally, the visibility of Moire fringe is good when the line and space of grating is almost same, in this experiment the visibility depending on the width of line and space of grating was tested. Clear tendency of the optimal L/S value depends on defect itself and also, we showed that the larger width of line than that of space is more effective as you can see in Fig. 5. In particular, when the width of L/S is 100/40㎛ or 100/50㎛, we can observe String viscous clearly. Accordingly, based on these results, we used grating film of 100/40㎛ and 100/50㎛ in width of L/S.

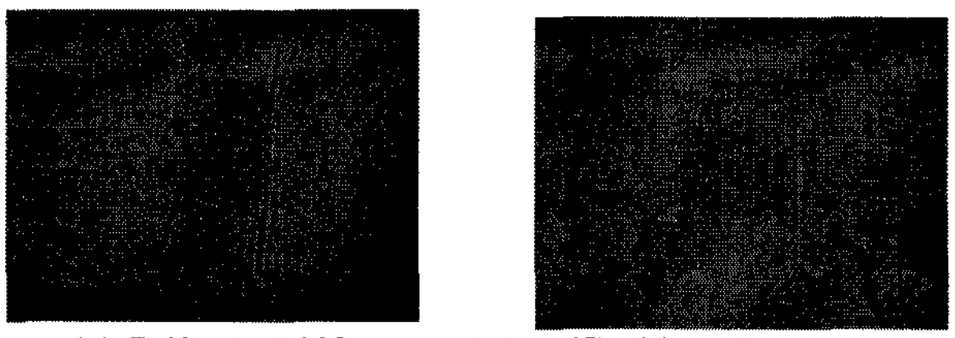
Based on the above, String viscous inspection equipment was manufactured as you can see in Fig. 6 and inspecting method is as follows:

When the glass is placed on the work guide, its stopper fixes it. Air bag typed grating film inflated or deflated with pressurized air is closely adhered in the vertical direction against the panel glass. The

inspection process is just operated under those conditions.



(a) L/S=100/20 **(b) L/S=100/30**



(c) L/S=100/40 **(d) L/S=100/50**

Figure 5. String Viscous Inspection according to the Grating L/S

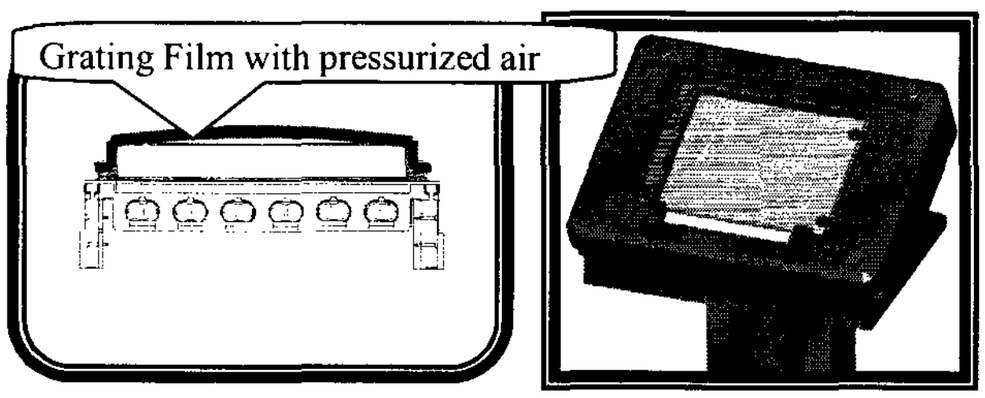


Figure 6. String Viscous Inspection Equipment

Following final inspection, we have additionally another process of inspecting String viscous to inspect panel glass again. Fig. 7 shows the ratio of defective from customer before and after one month.

The ratio of defects found before and after installing of the equipment showed the great difference in customer defective ratio. That is, in case of String viscous, about 3,300 PPM was dropped to 1,700 PPM by 1,600 PPM. This proves the effectiveness of the equipment.

3. Further Study

This grating formation method by contacting has an excellent visibility of String viscous. but it has some disadvantages-first, cycle time of inspection maybe prolonged. Second, film must be exchanged periodically. So, to make up for these disadvantages, we may consider grid formation method by non-contacting as follows;

First, grid mask is placed between lights and projection lens, and its image is projected through projection lens to mirror. then, as a result of it, the image of grid is formed on the surface of glass. It is because Flatron panel glass served as a screen. With this image, we can replace the film. Based on what was mentioned above, prototype was made. With this prototype, an experiment was conducted. As a result of the test, String viscous was found conspicuous.

However, compared with non-contacting method which used film, its visibility got lower. Here, several points to be improved are line sharpness, uniformity

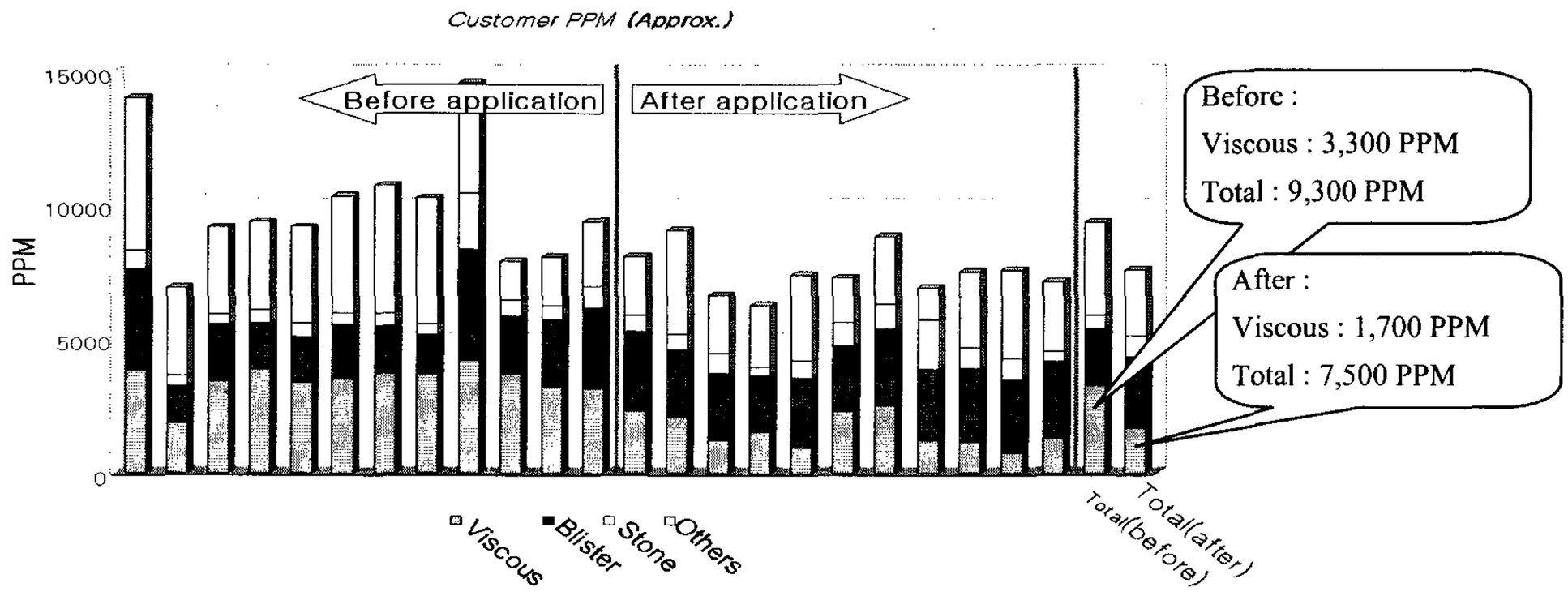


Fig. 7 The ratio of defective from customer(Approx.)

of the grating and others.

Therefore, the countermeasure will be reducing magnification ratio, by increasing grid size, by increasing the thickness of coating layer of film, and with the use of fly eye lens unit. After this study, the schematic configuration of the final system would be like this Fig. 4.

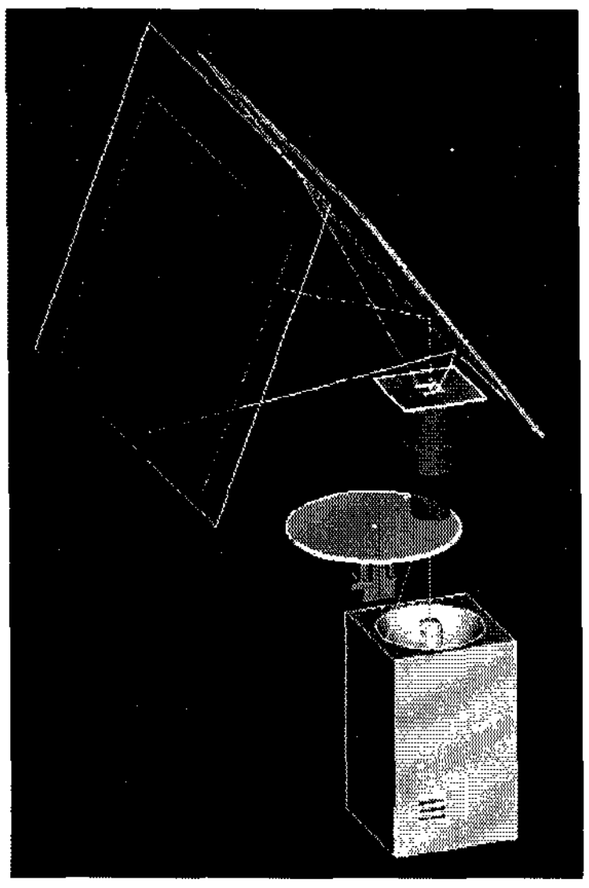


Figure 8. Final System Configuration

4. Conclusions

We presented the development of viscous inspection equipment for flatron panel glass by Moire phenomenon and proposed a new idea to develop an automatic inspection system for viscous or cord defects.

Based on the Moire Phenomenon, we could manufacture the inspection equipment and improve the visibility of String viscous in flatron panel glass.

Most of all, after using this equipment the defective ratio was dropped from 3,300 PPM to 1,700 PPM by 1,600 PPM.

Though non-contacting grid type is not significantly better than contacting film grid type, we found out the problems and drew out the countermeasure. Through this experiment, we make sure that this non-contacting type can be the key to develop the automatic inspection system for viscous, cord and other defects.

5. References

[1] Takasaki H., "Moire Topography", Applied Optics, Vol.9, No.6, pp.1467-1472, 1970

[2] Y.C. Park, "The Principle and Applications of Moire Phenomenon", Journal of Korean Society of Precision Engineering Vol.17, No.6, pp25-31,2000

[3] Daniel Malacara, "Optical Shop Testing", pp.402-406