Novel surface profiler system for inspection of flat panel display

Munehiro Kimura[1], Tetsuya Iwata[2] and Tadashi Akahane[1]

[1]Department of Electrical Engineering, Faculty of Engineering, Nagaoka University of Technology, 1603-1 Kamitomioka, Nagaoka, Niigata 940-2188, Japan

Phone&FAX 81-258-47-9540

e-mail: kimura@alcllan.nagaokaut.ac.jp

[2]Core System Co. Ltd., 2-2-2 Nakajima, Nagaoka, Niigata 940-0094, Japan

Abstract

Novel surface profiler system for inspection of the display components is demonstrated. In the case of the liquid crystal display, for example, not only the flatness of the alignment film but also the quality of rubbing can be inspected. Furthermore, the shape of the component such as the color filter, electrode and mirror can be inspected without removing each component.

Keywords: alignment film, liquid crystal, surface profiler, topology, product inspection

Oral/Poster Preference: Poster

Closest matching Symposium Topic: DISPLAY MEASUREMENTS

(Advances in Display Measurements, Equipment, Methods, and Technology)

No student included / No application session oriented

Technical Summary

Objective and Background

In a manufacturing process of flat panel display, in-line inspection is strongly demanded. Because, product yield rate can be improved by the intermediate inspection. In the case of the liquid crystal display (LCD), for example, it is well known that the rubbing processes is possible to give damage against the thin film transistor, therefore the rubbing strength is expected to be weak. As a result, sometimes the surface alignment is inadequate, and "mura" faulty can be found in final product. At present, a possible technique to find an effective rubbing strength before filling liquid crystal compound has not been established yet. It is no doubt that intermediate inspection just after the rubbing process can improve the product yield rate.

For the purpose of estimating the surface topology, surface profiler system by the use of laser optics has been developed by several researchers. The main object for the profiler system is solid state matter such as semiconductor wafer, hard disk and optical mirror. Generally say, the surface profiler system was applied for non-transparent medium rather than the transparent medium. Recently, a novel surface profiler system was developed by Core System Co. Ltd. It is a remarkable feature that the novel profiler system is applicable to transparent medium such as polymer film and finger print.

In this report, novel surface profiler system for inspection of the display components is demonstrated.

Measurement principle and Results

Figure 1 depicts the fundamental concept of the novel three–dimensional surface profiler instrument (Scanning Laser Imaging Scope, Core System Co. Ltd.). The laser light beam is scanning on the surface of the curved object with maintaining the distance l. Scanning direction is along the *x*–axis. The surface profile of the measured object along the x–axis can be expressed by the function $f(x)$. Now, assume that the light beam from the laser light source L is emitted on the curved object at the point P. When the angle θ with respect to the *x*–axis is much less than 1, the gradient at P can be

expressed by:

$$\frac{df(x)}{dx} = \tan\theta \sim \theta \qquad (1)$$

The angle between the incident light and the reflected light is approximated to 2θ, which corresponds to the deviation Δ from the incident light beam. Under such condition, Δ is approximated to 2θ*l*. When the deviation Δ is measured by scanning an object, the distribution function of the surface profile *f*(x) can be obtained by the measurement of Δ(*x*). From the equation (1), *f*(*x*) can be derived by:

$$\alpha \int dx\Delta(x) = \int dx\theta(x) = f(x) \qquad (2)$$

where α = 1/2*l*. The coefficient α can be determined by the calibration measurement with the known object. Sequential scanning with the two dimensional direction can provide the three–dimensional surface profile.

Figure 2 shows the typical experimental result of the surface topology of the LCD panel, where the polyimide alignment layer, color filter, transparent electrode, reflection mirror were prepared on the glass substrate. The scanned area is 40 x 40 mm^2, and scan was completed within 20 min. It is noteworthy to point out that the topological shape of the concave mirror with hole can be clearly recognized. Here, it is quite beneficial that the transparent layer such as polyimide and electrode layer are not required to be removed beforehand.

Inpact

Generally, analysis on LCD panel was carried by using atomic force microscope (AFM) or scanning electron microscope (SEM). The short comings of these instruments are as follows: it is not applicable to real display product. In the case of the inspection of the reflection mirror by means of the AFM measurement, alignment film and transparent electrode should be removed beforehand. Besides, the scanning area is much less than 100 x 100 square micrometer, and its required time for scanning is more than hours.

The merits of the novel profiler are short measurement time and simple procedure for visualization of topology. This means that our novel profiler is applicable to inspection of real product as an intermediate inspection.

References

1) R. Barberi, I. Dozov, M. Giocondo, M. Iovane, Ph. Martinot–Lagarde, D. Stoenescu, S.Toncheu, and L. V. Tsonev, Eur. Phys. J. B **6** (1998) 83–91.

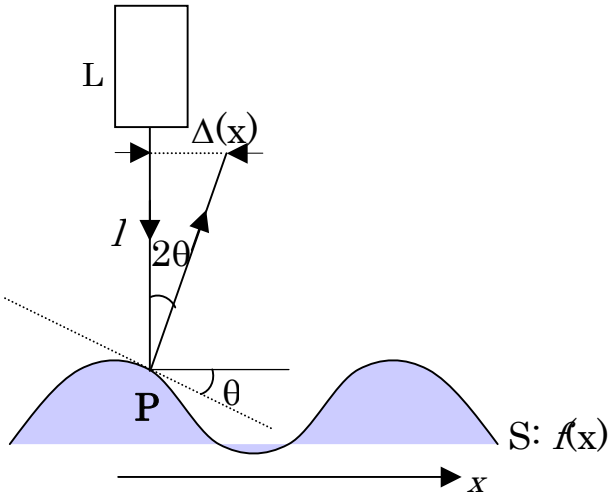

Figure 1 Basic concept of the profile measurement

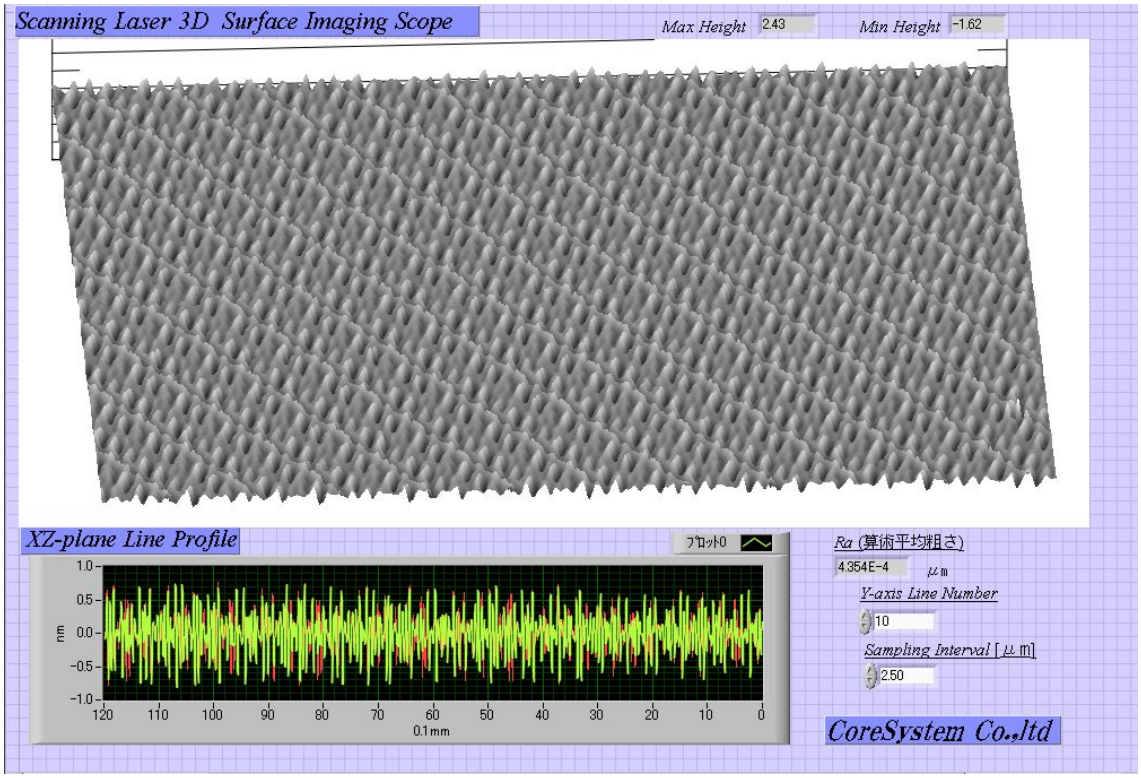

Figure 2 Typical experimental result measured by the novel profiler.

Novel surface profiler system for inspection of flat panel display