TW(True Wide)-IPS for Improvement of Display Performance in large size TV application

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Abstract

Super In Plane Switching (S-IPS) technology is applied for large TFT-LCD panels used in TV applications. It has a lot of advantages in comparison to the alternative, VA technology. S-IPS shows excellent viewing angle properties and fast response time between intermediate gray levels. If the performance parameters which describe the actual visual performance are considered, S-IPS is much more advantageous.[1]

However, it shows relatively low contrast ratio in diagonal direction compared to viewing angle characteristic in upper/down direction in S-IPS.

In order to compensate the relatively low diagonal contrast ratio, a newly designed optical film was applied and the truly wide view angle of a S-IPS TW(True Wide)-IPS) was achieved.

Our newly developed 30-inch TFT-LCD panel reveals TW-IPS that is optimized for TV application

Introduction

Several types of display like flat-CRT, PDP, LCD are competing with each other for emerging HDTV market. It looks that PDP is a promising candidate for the leading display of HDTV because of efficient manufacture together with the desirable features of a flat panel display. But increasing manufacturing glass size enables manufacture of LCD panels with more than 40inches diagonal which can compete effectively with PDPs. Table 1 compares the specification of several display types including LCD TV and PDP TV. It is noticeable that PDP shows response time of the order of micro seconds because of the intrinsic property of impulse devices. On other hand, the resolution of PDPs is not as high as that of LCDs. Although the viewing angle characteristics of super IPS are good enough for TV applications, it is necessary for IPS products with large screen size more than 40" to get additional viewing angle improvement especially for diagonal direction. They have to compete with PDP.

Why is S-IPS in TV application?

When the viewing angle of the black state of a NW (Normally White) TN or a NB (Normally Black) VA(Vertically Aligned) mode is considered, the main issue is the change in retardation of the liquid crystal layer as a function of the angle of view.[2]

In the case of the S-IPS mode, the effect of the change in retardation of the liquid crystal layer shows a lower angular dependence of retardation in comparison with the other LCDs (especially VA(Vertical Aligned) mode, due to the alignment of the liquid crystal director.

However, there is another factor that can effect the light leakage of the black state in all of these devices, and that is the viewing angle dependence of the light transmission of crossed polarizers.[3] When viewed at oblique angles, from geometrical considerations, the polarizers do not appear crossed and increased light transmission results. Chen et al. [3] have shown the use of optical compensation films can be used to greatly reduce the affect.

	Requirement	LCD TV	PDP TV	CRT TV	Projection TV
Size	20"~	~52"	30"~60"	10"~40"	40"~
Space	Small	◎+	◎	△	△
Resolution	SVGA~	◎+	○	○	○
Response Time	~10msec	○→◎	◎	◎	◎
Viewing Angle	>170˚	○→◎	◎	◎	◎
Brightness	450nit~	◎	○	◎	○
Power Consumption	~100W	◎	△	○	△
Life Time	50,000hrs~	◎	△	◎	○

(◎ : High ○ : Average △ : Low)

Table 1. The comparison of LCD and PDP

Principal of light leakage in S-IPS

The light leakage from crossed polarizer is explained as follows. Generally, if two polarizers are stacked with their absorption axis at azimuth $\varphi = 0°$ and $\varphi = 90°$, respectively(crossed polarizer), and one observes them from the plane at azimuth $\varphi = 45°$, the effective angle between the absorption axes of the two polarizers increases with the polar angle of the observing direction.[4~6]

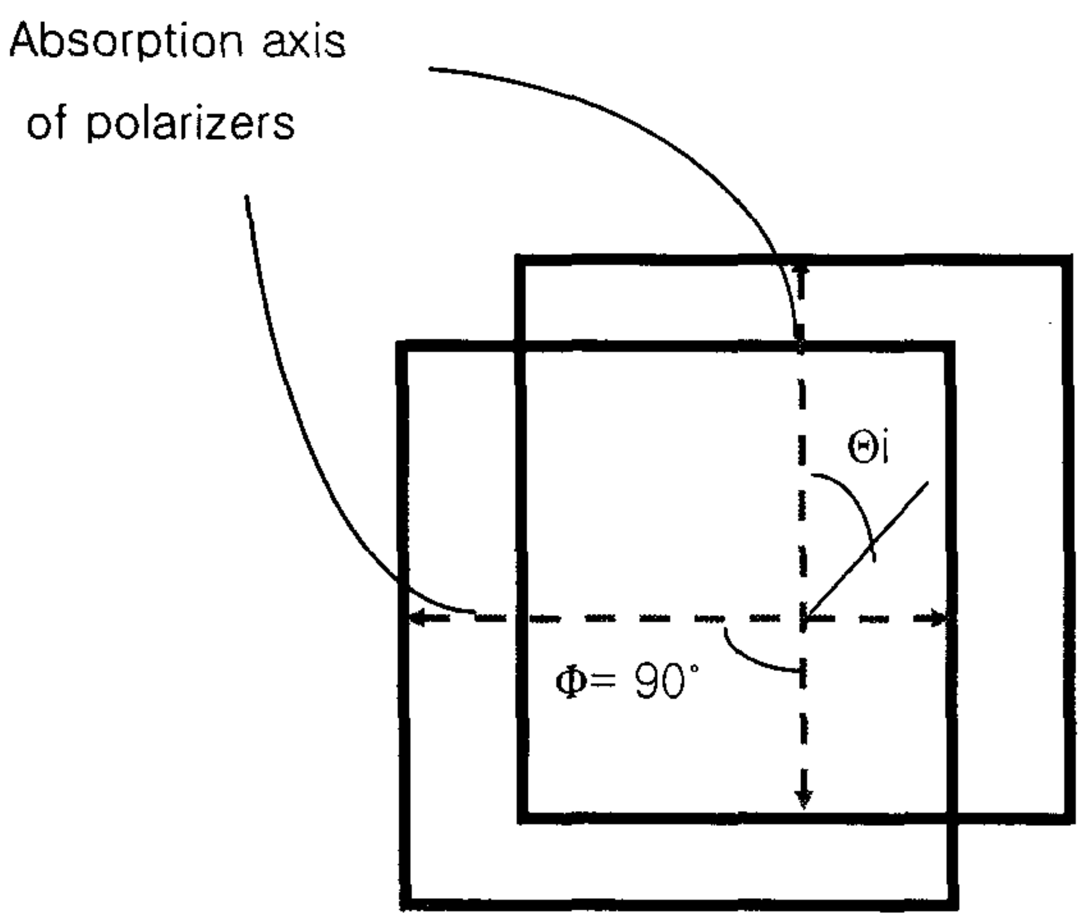

Fig.1. A principal of light leakage in the crossed polarizers

Experiment

<u>Simulation of TW-IPS</u>

Chen et al.[3] have shown a combination of a positive A plate with a positive C plate(or a negative A plate with a negative C plate). We utilized the method proposed by Saitoh et al. [5] for compensation by one biaxial film

As a reference we simulated the viewing angle of S-IPS with no compensation film, which shows a reasonably wide viewing angle (Fig .2)

However, the viewing angle may be further increased if compensation is employed to correct for the viewing angle dependence of the polarizers. (Fig 3.)

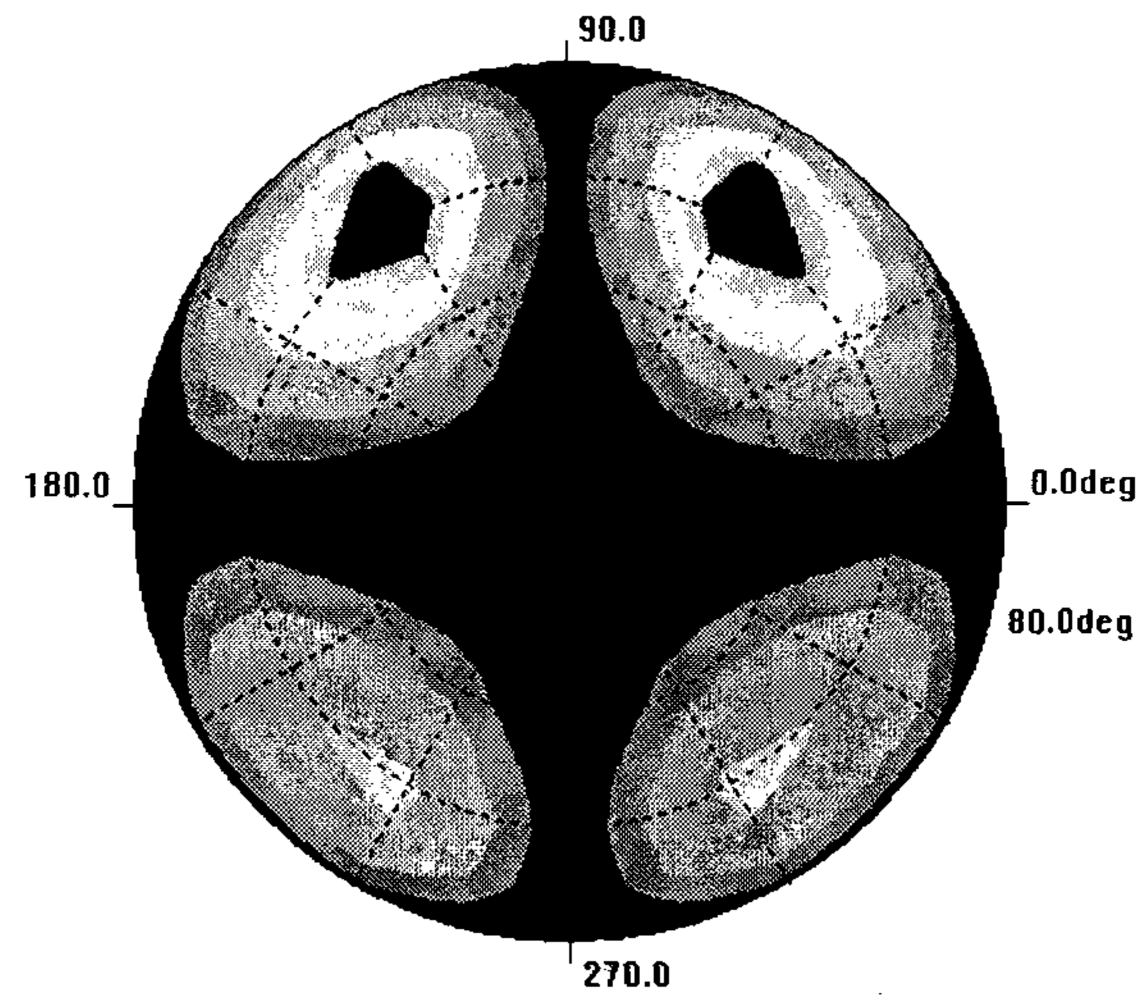

Fig. 2. Brightness of Black state in S-IPS

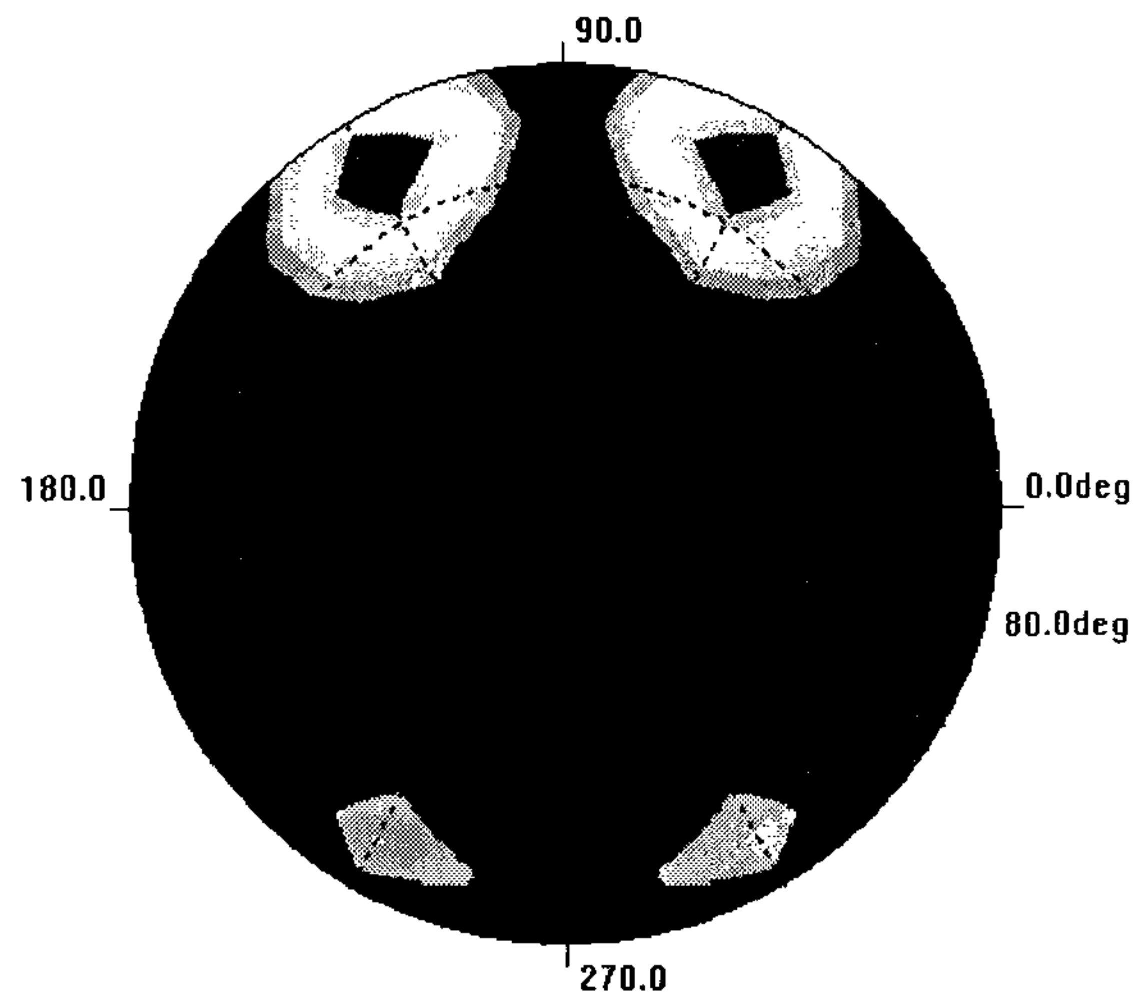

Fig. 3. Brightness of Black state in TW-IPS

<u>Actual results of Viewing angle for TW-IPS</u>

Using a TW-IPS with the compensation films and a panel filled with Merck liquid crystal mixture with birefringence of 0.08, the viewing angle was measured. The viewing angle dependence of S-IPS is shown in Fig. 4. and an extremely increased viewing angle of dependence for TW-IPS in diagonal direction is shown in Fig. 5.

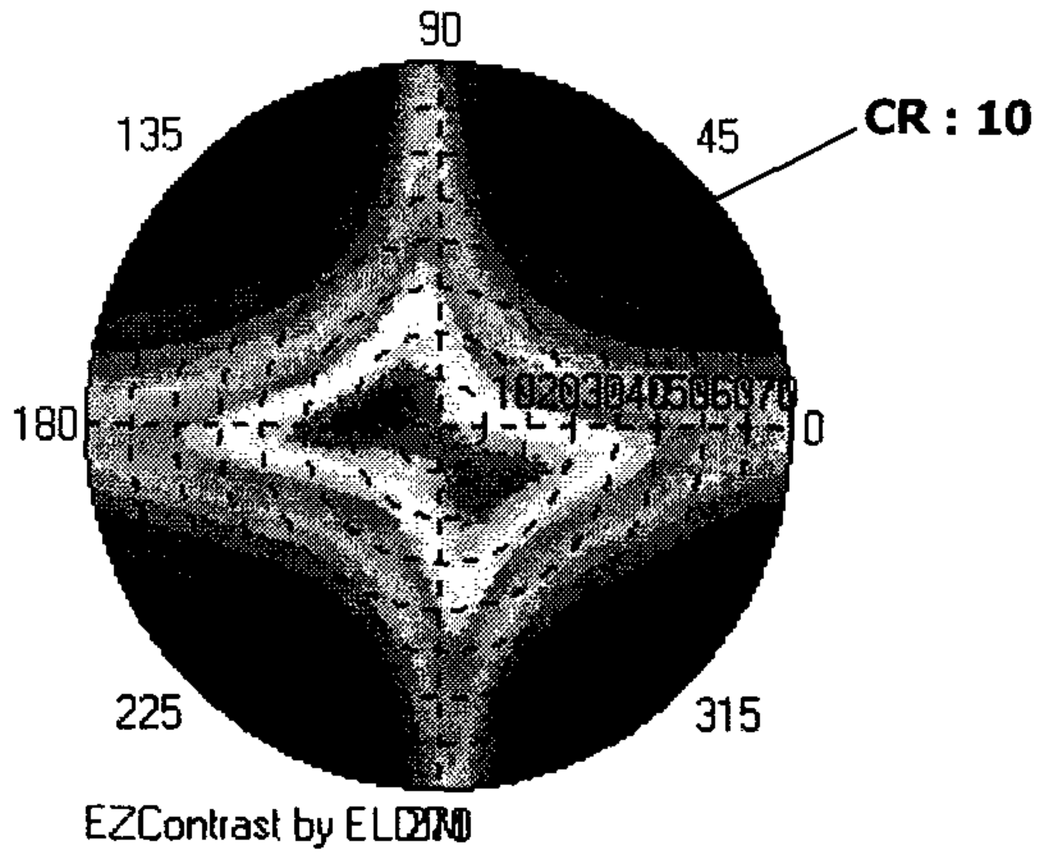

Fig. 4. The viewing angle of S-IPS

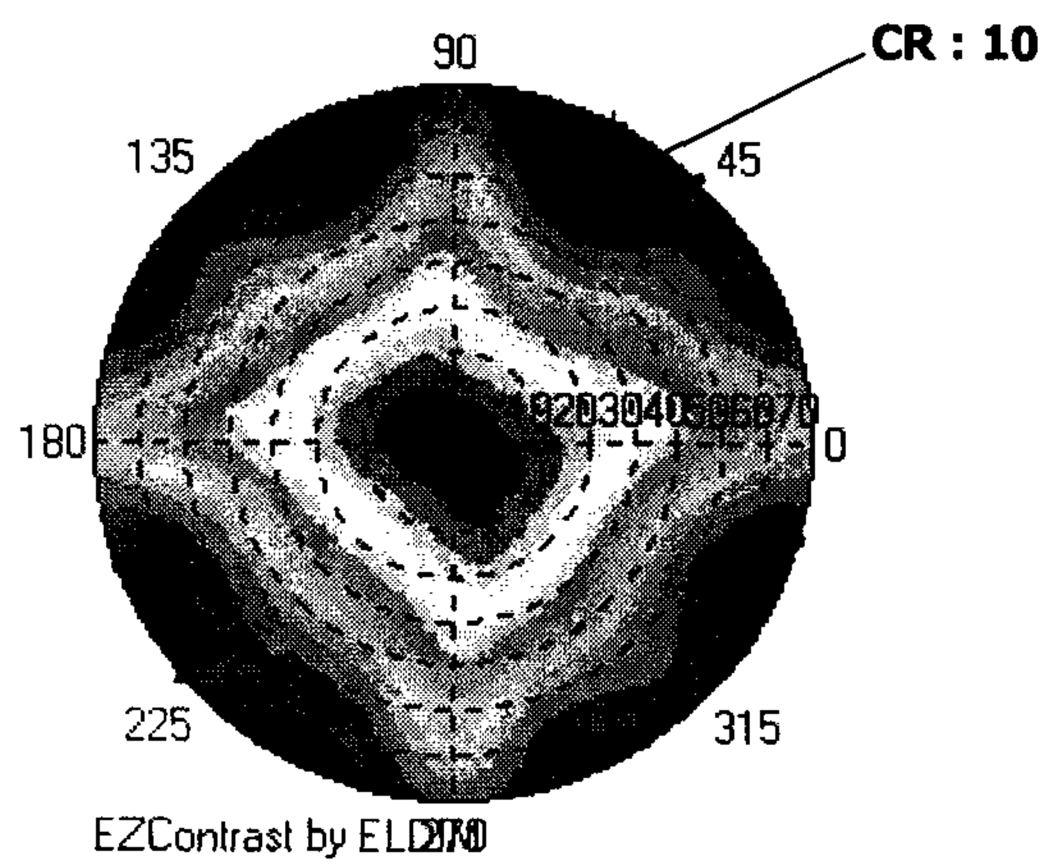

Fig. 5. The viewing angle of TW-IPS

To see real displayed images, we compared conventional S-IPS and TW-IPS of a 30" TFT-LCD. Conventional S-IPS is shown in Fig. 6. TW-IPS is shown in Fig. 7. TW-IPS is optically compensated and the light leakage in diagonal direction is very low.

Results and Discussion

We investigated the optical properties of biaxial optical compensation films and proved that TW-IPS shows significantly improved properties suitable for large size TV application.

We believe that larger LCDs can compete with other flat panel displays like PDP. The presence of TW-IPS technology enables LCD to win over PDP even in case of very large screen sizes more than 40".which has been believed to be advantageous over LCD.

Acknowledgement

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Reference

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[8] see " Optical Films for Liquid Crystal Display Data Sheets" from Nitto Denko

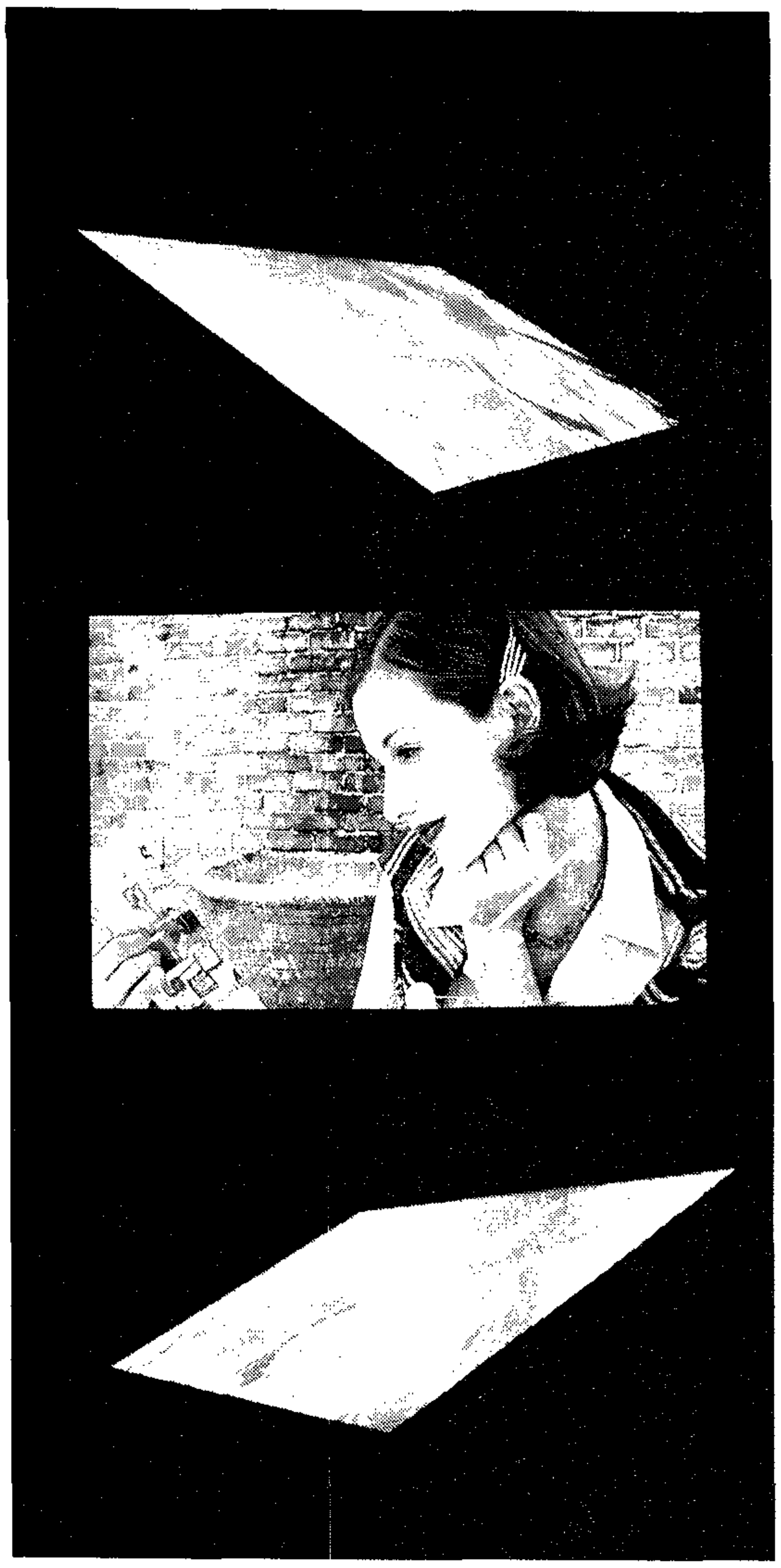

Fig. 6. A real image of S-IPS

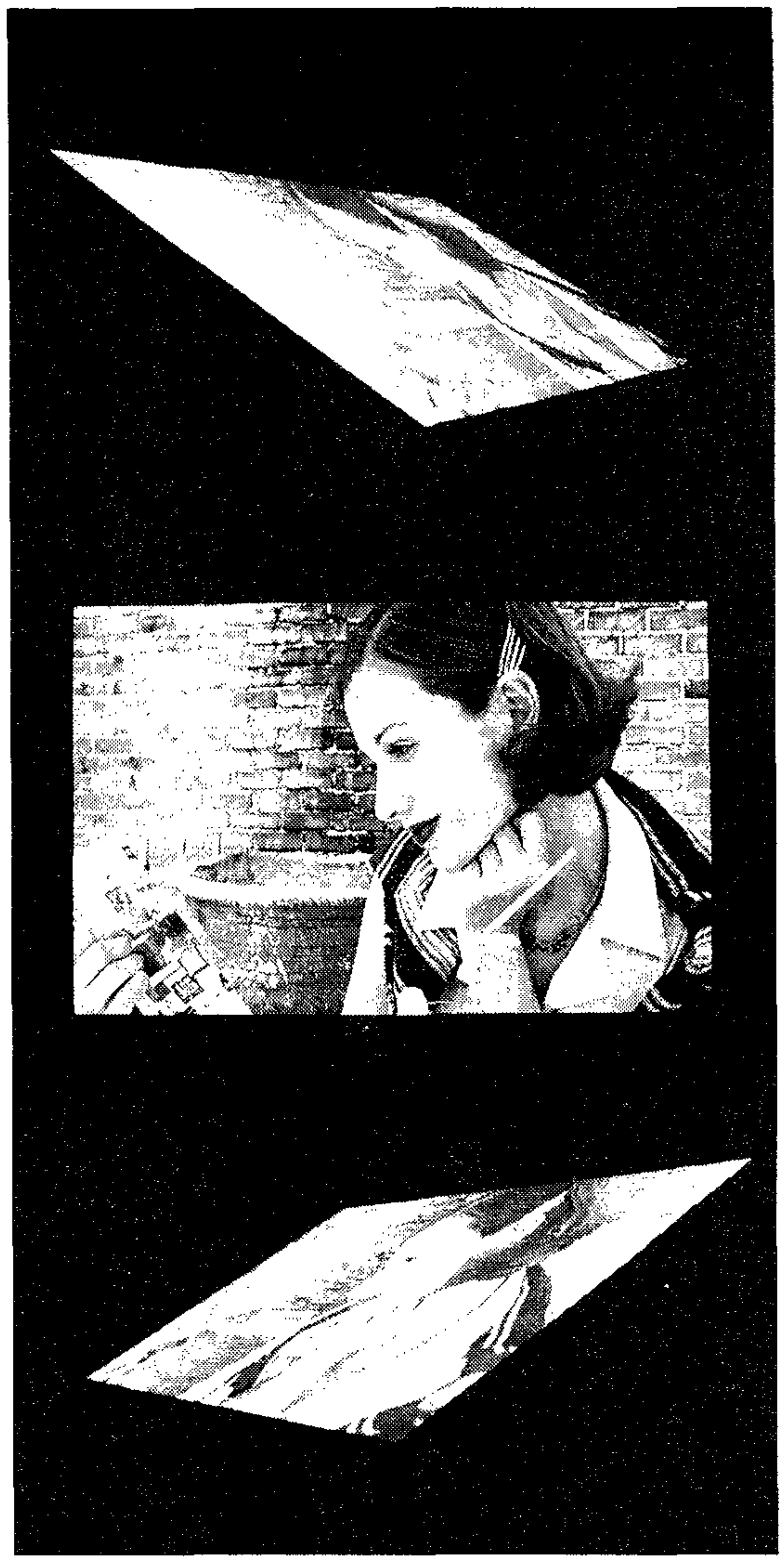

Fig. 7. A real image of TW-IPS