Application of a foil transfer for CRT Screen processing

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Abstract

LG Electronics developed a perfect flat color display tube which was named "FLATRON". This tube provides ergonomic performances with perfectly flat face and innovative manufacturing process. Foil transfer is a new technology for manufacturing screen layer for Flatron. Its main features include several properties of film, releasing agent, adhesive, aluminum layer, holes after bake-out and foil transfer process. It will be used innovative and cost oriented process for FLATRON for in CRT mass production..

1. Introduction

FLATRON

LG Electronics developed a perfect flat color display tube which was named "FLATRON"[1] . This tube provides ergonomic performances with perfectly flat face and innovative manufacturing process

Foil transfer technology is based on stamping foil and heat transfer.

Stamping foil

Stamping foil is a dry printing process in which a color pigment or metallic material is transferred from a continuous film sheet to the object being decorated. The application of the controlled heat and pressure releases pigment or the metal from the carrier film using an image dry or roller and bonds it permanently to the chosen object. The process is clean, dry and fast, and free from problems commonly associated with filming and evaporation processes.

In this paper we will introduce that we developed stamping foil for metal back on phosphor screen. The foil of 4 layer consists of base film, releasing layer, aluminum layer and adhesive layer.

Base film is one of polyethylene, polyester, poly vinyl chloride, poly propylene, polycarbonate, polyvinyl alcohol. Releasing layer on base film is made from one of poly styrene, poly methylmethacrylate, poly vinyl chloride. Urea resin, phenol resin and poly vinylidene chloride. The material of metal on the releasing layer is silver or aluminum. Adhesive layer on metal layer is made from one of paraffin wax, microcrystalline wax, ethylene acetate copolymer, poly ester, poly amide, and poly ethylene glycol.

Heat Transfer

In general heat transfer applications can be applied to a variety of substrates and range from appliances and automotive to sporting goods, toys, apparel, medical devices, interiors, etc. In the FLATRON process, heat transfers provide an attractive, economical, more durable, more sophisticated and more affordable way to make reflection layer on substrates. Heat transfers can be applied by a stamping die in a vertical application or with a silicone rubber roller. The basis of the transfer is heat and pressure to create a durable union of product and heat transfer. Most filming and evaporation process methods involved bigger equipment, higher cost, and disposal of fumes and solvents, which induce environmental issues. Whereas heat transfers are received to be dry. The process involves combining heat and pressure to release the film and aluminum layer from the polymer carrier on phosphor pattern. This process is environmentally friendly.

2. Preparation

2.1 Preparation of foil transfer film

In table 1, Base film is 25μm of PET manufactured by KOLON.

Table 1. Specification of foil transfer for FLATRON

layer	Material	thickness
base film	PET	25 ㎛
releasing layer	PMMA-3% copolymer	2 ㎛
metalizing layer	Aluminum	900 Å
adhesive layer	ethyl methacrylate or copolyamide	2 ㎛

KOLON-PET has outstanding properties of heat stability, transparency and durability. This properties allow successful vacuum metallizing, and offer tremendous potential for developing new products.

This bioriented film has not only excellent mechanical and physical properties but also good chemical and thermal stability enabling itself to be applied for packaging material, hot stamping foil, transfer and industrial use. In table 1, Releasing layer is KA-111. KA-111 has good releasing property (See Table 2)

KA-111 >> KA-211 = KA-411 = KA-221 > KA-321 > KA-511

KA-111 is composed of PMMA-3% copolymer and the thermal decomposition property of KA-111 is same as that of conventional polymer like PVA.(See Figure 1 (a))

Table 2. Optimization of releasing layer

sample	Composition	Separa tion	Transfer property	
			135℃	140℃
KA-111	PMMA-3%copolymer	◎	0	0
KA-211	PMMA-5%copolymer	0	△	0
KA-411	isobutyl metacylate	0	△	0
KA-221	KA-111/KA-211 1:1 Blend	0	X	0
KA-321	KA-111/KA-411 1:1 Blend	△	X	X
KA-511	ethyl methacrylate	X	X	X

0 : 100% released

△ : 80%~ 95% released

X : below 50% released

In table 1, metalizing layer is aluminum.because aluminum is light reflector, good electrical conductor and cheap almost same as silver and adhesive layer is ethyl methacrylate(Table 3) or copolyamide (Table 4). Ethyl methacrylate is used in foil transfer process on lower temperature, the higher thickness is the better transfer and the higher temperature is the better transfer. Copolyamide is used in foil transfer process on lower temperature and the higher thickness is the better transfer and the higher temperature is the better transfer. Thermal decomposition property of two adhesive polymer is same as that of conventional polymer like lacquer filming(See Figure. 1 (b))

After bake out during 30 minutes at 450℃. Residual volume is below 5%. Decomposition temperature(Td) between releasing agent KA-111 and adhesive agent is different , initial decomposition temperature(Tdi) of releasing agent KA-111 is 352-430℃ and Tdi of adhesive agent is 279-405℃. So after bake-out there is no aluminum blister.

Foil transfer film is made as follows

1) releasing layer coated by gravure coater

2) metal layer evaporated by Roll to roll method

3) adhesive layer coated by by gravure coater

4) slitting and micro-slitting cut by slitter

Table 3. Optimization of adhesive layer transferrable at higher temperature

Temp. of roll(℃)	Thickness(㎛)			
	1.5	2.0	2.3	2.6
140	X	0	0	0
135	X	△	0	0
130	X	△	△	0
125	X	X	X	0
120	X	X	X	0
115	X	X	X	X

0 : 100% transferred

△ : 80%~ 95% transferred

X : below 50% transferred

adhesive : ethyl methacrylate

thickness of releasing layer: 2㎛ of KA-111

Table 4. Optimization of adhesive layer transferrable at lower temperature

Temp. of roll(℃)	Thickness(㎛)		
℃	2.0	2.3	2.6
80	0	0	0
70	0	0	0
60	△	0	0
50	X	△	0
40	X	X	0
30	X	X	0

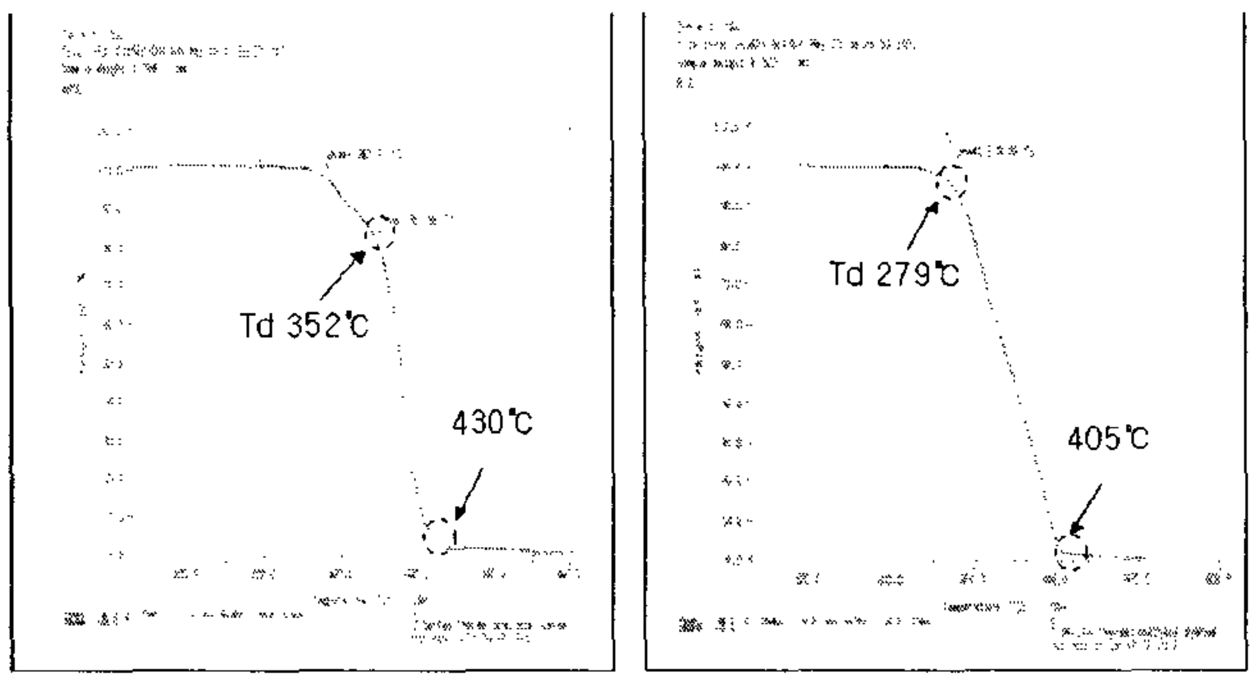
0 : 100% transferred

△ : 80%~ 95% transferred

X : below 50% transferred

adhesive : copolyamide

thickness of releasing layer: 2㎛ of KA-111



(a) (b)

Figure. 1. Thermal decomposition property

(a) Releasing agent of KA-111

(b) Adhesive agent of copolyamide

2.2 Preparation of foil transfer machine

FLATRON panel is perfectly flat and has a rail which is directly attached onto the panel inside with a frit glass at a high temperature. So the width of roll is shorter than length of rail. Foil transfer machine used in this paper is shown in Figure.2

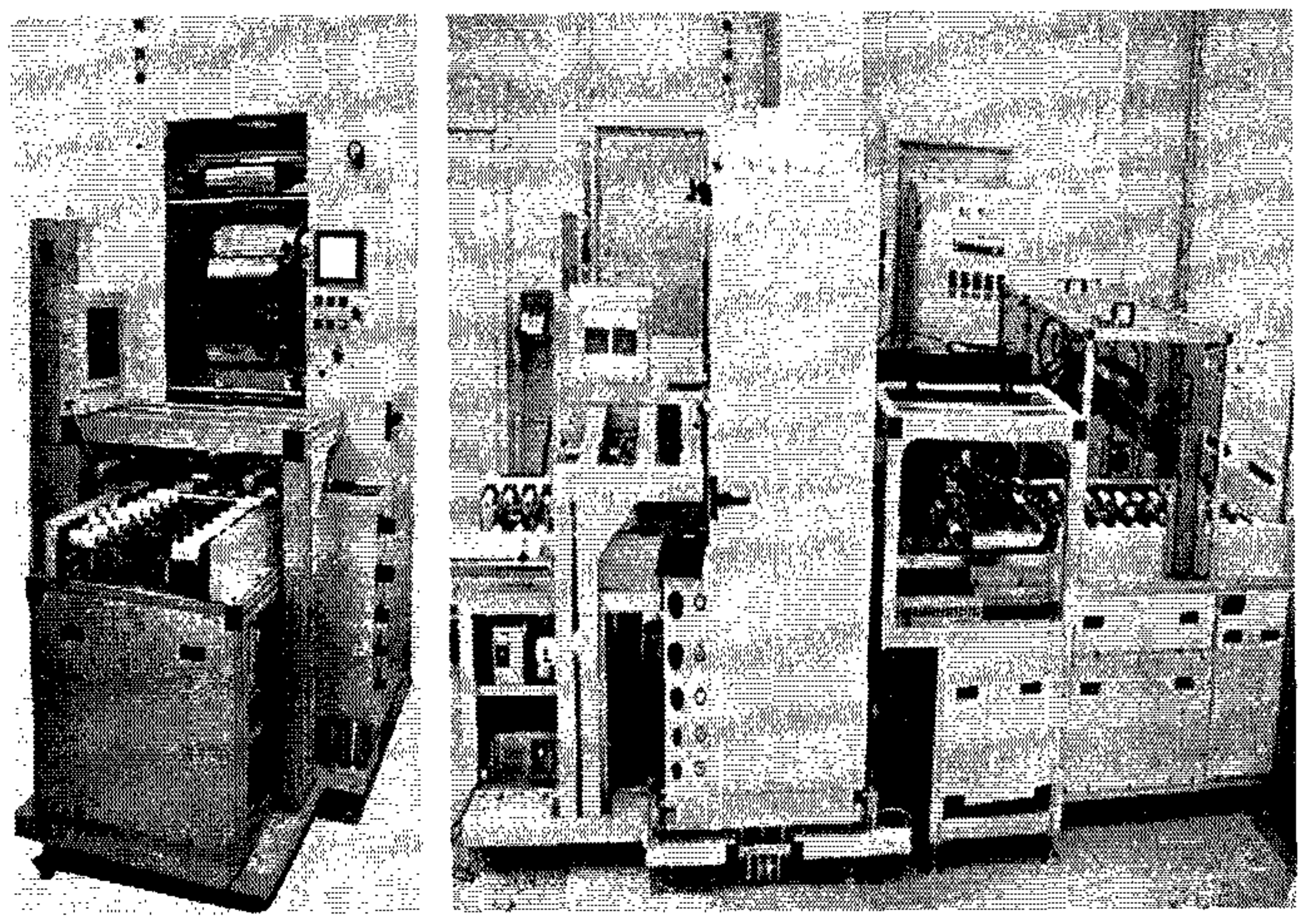
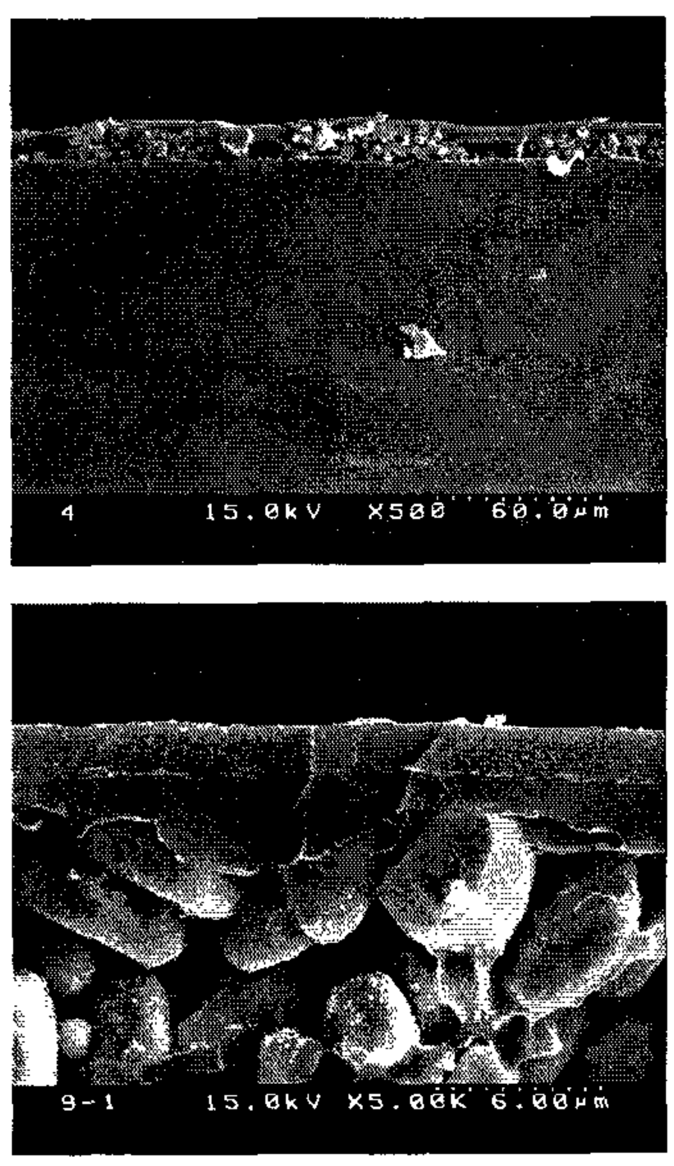


Figure. 2. foil transfer machine

3. Results

3.1 Formation of metal back by foil transfer process

Each black matrix, R,G and B phosphor are coated by coating machine on the panel glass. Foil transfer film is laid by foil transfer on the black matrix, R,G,B phosphor. coated on panel glass that the panel glass is heated up to 100± 5℃ by oven. Foil transfer film and panel glass moves on pressure roller. Foil transfer film is transferred on phosphor layer by thermal energy and pressure from hot roller, and then base film.is removed by peeler As a result, we make metal back layer on the phosphor layer(Figure 3)



(a) × 500

(b) × 5000

Figure. 3. Metal back layer made by transfer pressure

3.2 Uniformity of metal layer made by foil transfer process

This metal layer by foil transfer process is much more uniform than conventional metal layer (see Figure 4) because foil transfer film is made by roll to roll process. So white uniformity of this screen is better than that of conventional screen

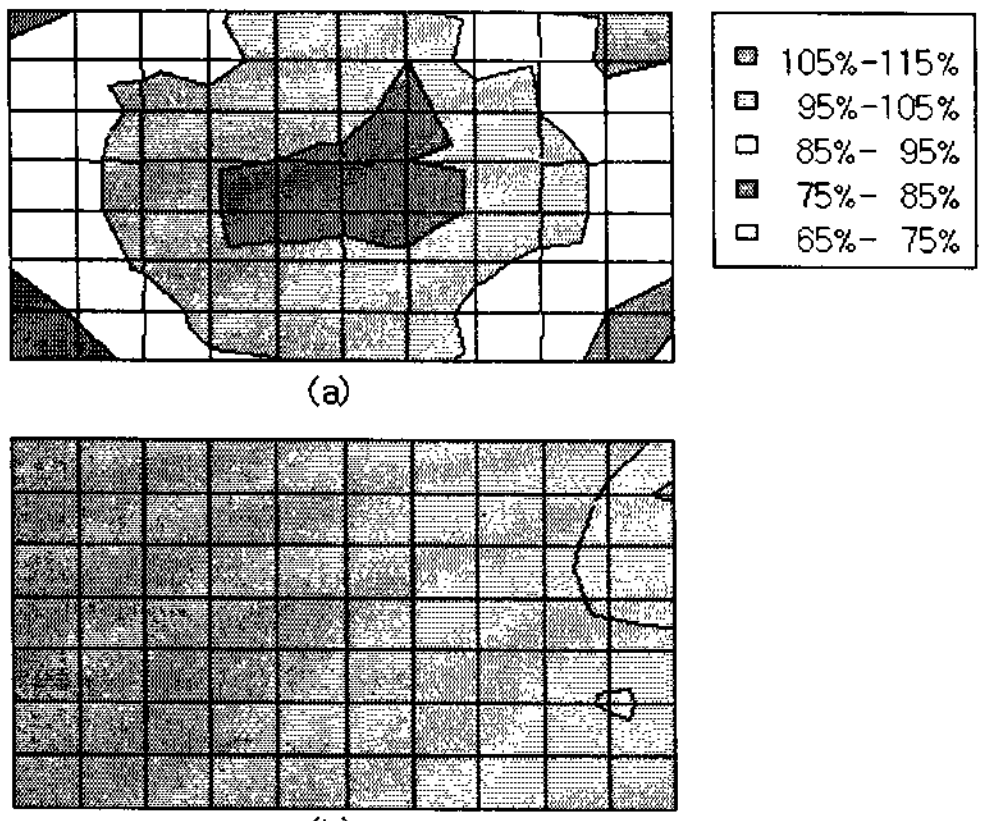
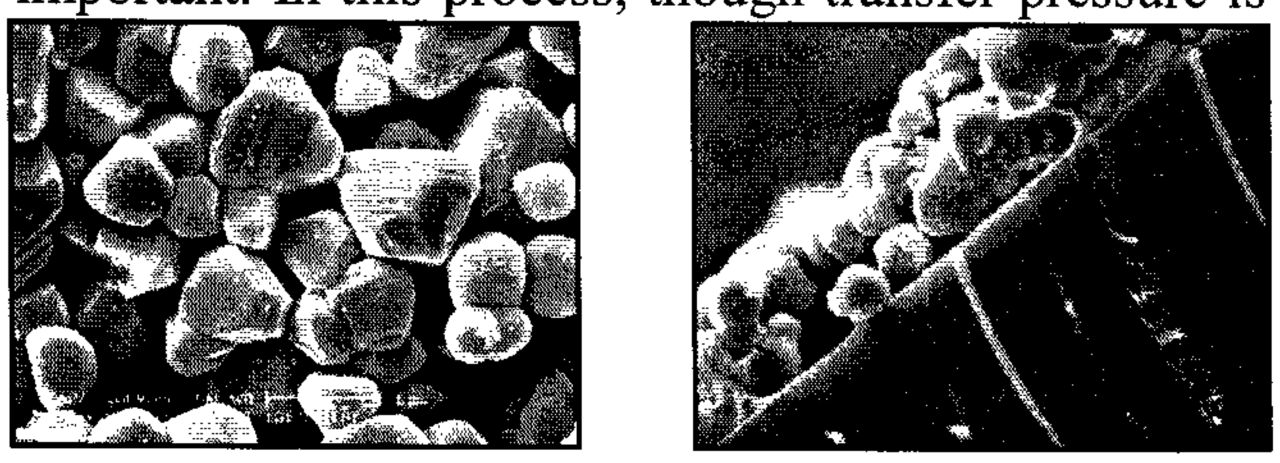


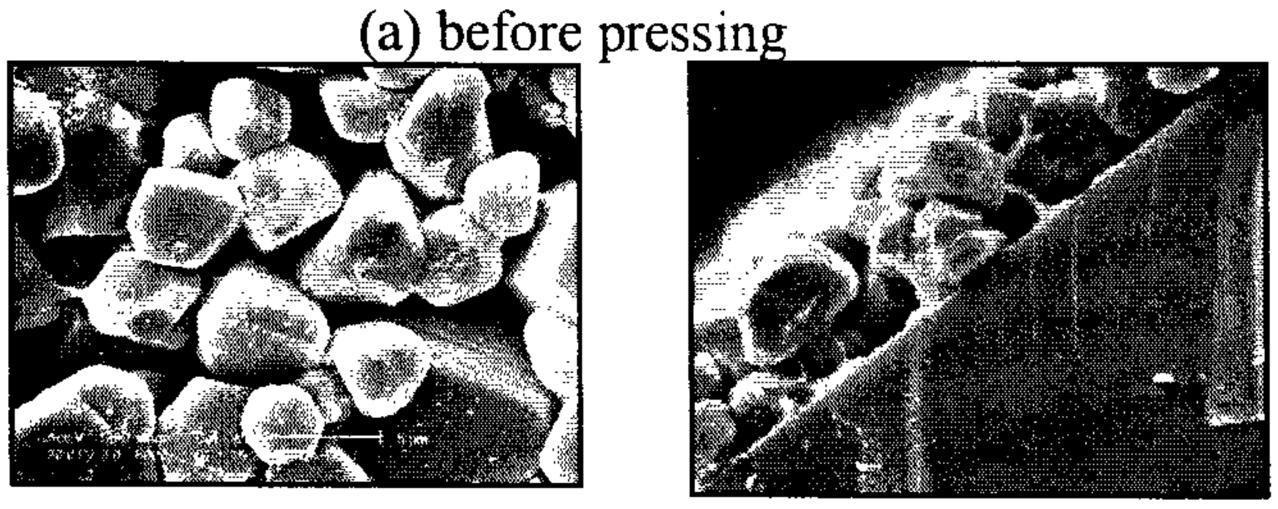
Fig. 4. Metal back layer distribution

3.3 Stability of phosphor layer

During the transfer, hot roller is pressed by air cylinder till 5kg/㎠. So stability of phosphor is important. In this process, though transfer pressure is 6.5kg/㎠, the structure of phosphor layer is not changed.(See Figure. 5)



(a) before pressing

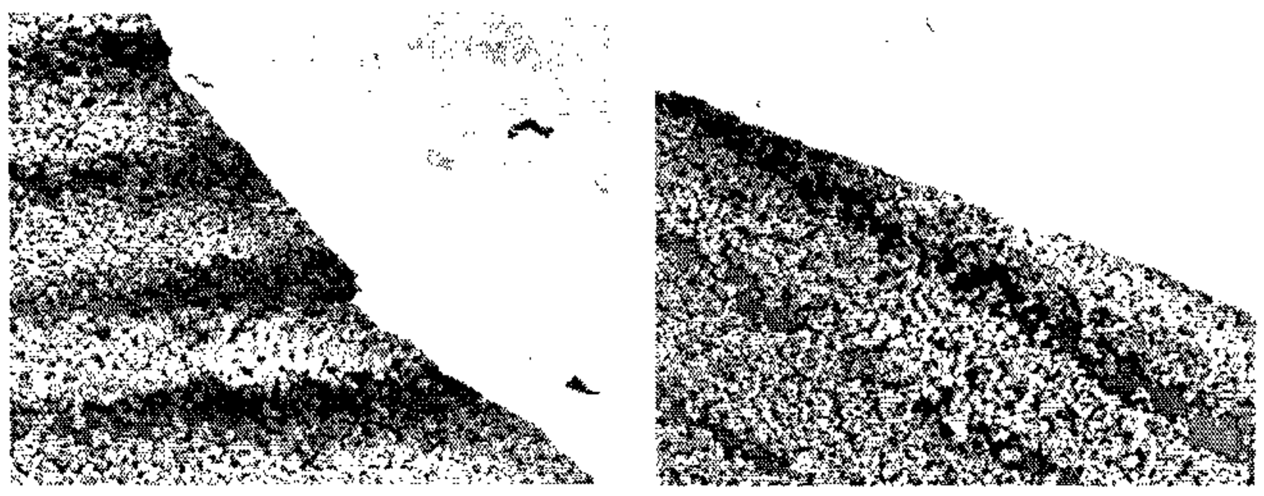


(b) after pressing(6.5kg/㎠)

Figure. 5. Micro structure of phosphor structure by transfer pressure

3.4 flatness of metal layer made by foil transfer process

Because metal layer is deposited by evaporation on flat releasing layer by gravure printing, the flatness of metal layer on releasing layer is much higher than the flatness of metal layer on phosphor layer(See Figure 6). Whereas light refractance of metal surface made by evaporation on phosphor is 80～90%, light refractance of metal surface made by roll to roll evaporation on releasing layer is 85～99%. So performance of metal layer is better, brightness is higher. Futhermore this foil transfer process can be not only removal of organic filming process and metal back layer process but also reduction of long CRT process.



(a) (b)

Figure. 6. Flatness of metal back layer on phosphor screen

(a) conventional metal layer
(b) metal layer in this paper

4. Acknowledgements

We thank to OTS Technology and J.B Choi of LG Philips Displays for helping us to develop foil transfer process. (See Figure 2).

5. References

[1] N.J. Koh , LG Electronics Inc. "17"Perfect Flat Color Display Tube FLATRON",.IDW '97 ,p469-472 (1997)