

# ORGANIC PHOTOCONDUCTOR FOR PRINTER

Seishi Terasaki  
Shigemichi Itoh  
Atsushi Asamura

## 1. INTRODUCTION

Desktop-type page printers have gained wide acceptance in the market because they can produce high resolution images faster and with less noise than impact dot printers.

These printers have a photoconductor unit and toner unit which may be easily replaced by the user. Usually organic photoconductors are used in these printers because of their ease of handling and low price.

A variety of printers, such as a low-end printer which uses a low luminous intensity exposure source and a middle-class printer in which the interface and data processing are enhanced, have been developed. Applications such as these require the organic photoconductor to have high photo sensitivity and high reliability. Moreover, as the page description language of the printers is improved, the organic photoconductor should be compatible with each new printing process and be able to produce precise, clear images.

Fuji Electric has developed an organic photoconductor which meets the above criteria. This paper describes the photoconductor called Type 8B.

## 2. OUTLINE OF TYPE 8B PHOTOCONDUCTOR

Figure 1 shows the construction of the Type 8B photoconductor. An aluminum tube with special machining on the surface to enhance print quality is used as the conductive substrate. An anodized layer or resin layer is used as the insulating layer. The charge generation layer consists of charge generating material and binder resin. The main components of the charge transport layer are charge transport material and binder resin, however, levelizer, anti-oxidant, coloring agent, etc. are added. All layers are applied in a specified thickness to the surface of the aluminum tube by a dip coating process.

The size of the photoconductor usually is determined by the print speed and the paper size. Fuji Electric produces a variety of photoconductors which may be used in almost any kind of printer as shown in Fig. 2.

Fig. 1 Layer structure

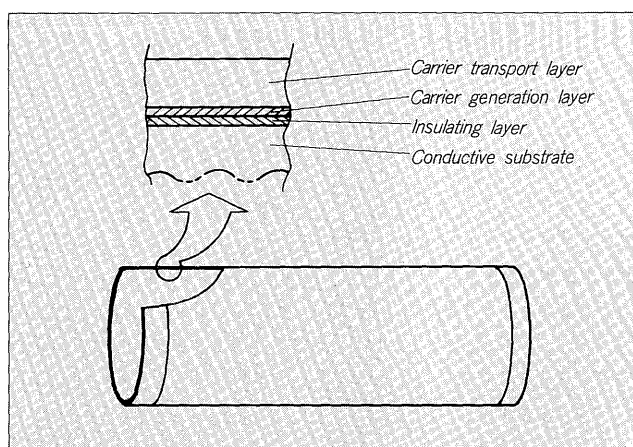
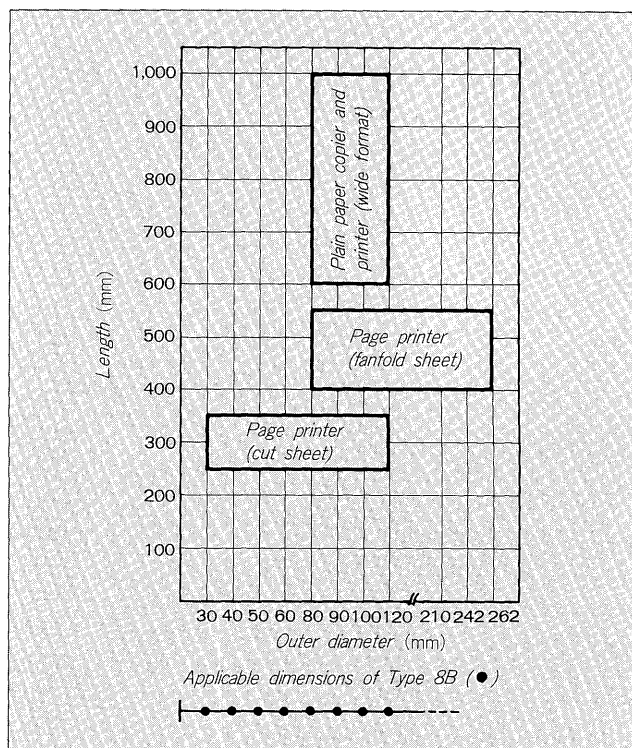


Fig. 2 Electrophotographic products and applicable dimensions



### 3. PROPERTIES OF TYPE 8B PHOTOCONDUCTOR

- 1) The development of photoconductive materials with high function gives the Type 8B photoconductor a high level of sensitivity which is not affected by the wavelength of the exposure source and also allows widely adjustable sensitivity.
- 2) Type 8B photoconductor has long print life due to combination of high wear resistance resin and high-function organic photoconductive material.
- 3) Due to our highly developed printer process evaluation technology, the Type 8B photoconductor can be used in any printer.
- 4) Type 8B photoconductor uses chemicals which have been proven to be safe.

#### 3.1 High sensitivity

The sensitivity of the photoconductor depends on the carrier generation efficiency at the charge generation layer, carrier injection efficiency from the charge generation layer to the charge transport layer and the carrier mobility at the carrier transport layer. For these reasons Type 8B photoconductor uses phthalocyanine which has high carrier generation efficiency and a hydrazone derivative with high carrier mobility. To obtain a high carrier injection efficiency, the ionization potentials of the above materials are carefully matched.

Table 1 shows the electrostatic characteristics of Type 8B. The half decay exposure, that is the sensitivity, is  $0.25\mu\text{J}/\text{cm}^2$ .

Figure 3 shows the spectral sensitivity of Type 8B. Generally, an LED of wavelength 650 - 730 nm or an LD of wavelength of approximately 780 nm is used as the exposure source of the printers. Type 8B has panchromatic characteristics at the above wavelengths.

The photoconductor for a high resolution printer has to produce a clear electric image on the boundary between the exposed and unexposed areas in order to prevent a poor image with toner blotting. Figure 4 shows the electrical characteristics (photo induced decay characteristics) of the Type 8B photoconductor. Since surface potential decreases rapidly under medium intensity exposing, Type 8B will achieve high line resolution.

The photoconductor for a high speed printer is required to decrease the exposed potential quickly, in other words, have quick photo response. Photo response depends on the carrier mobility of the materials. For this reason Type 8B photoconductor uses transport material of high mobility such as  $1 \times 10^{-5} \text{ cm}^2/\text{V}\cdot\text{s}$ . Figure 5 shows the photo response of Type 8B under three different conditions. The range of fluctuation of exposed potential among the three conditions is very small.

#### 3.2 Long print life

Print life of the photoconductor depends on its mechanical and electrical characteristics. Mechanical characteristics are deteriorated by wear, scratches and foreign

Table 1 Electrostatic characteristics

Dark decay rate		Half decay exposure		Residual potential after $5 \mu\text{J}/\text{cm}^2$
1 sec. after exposure	5 sec. after exposure	wavelength 660 nm	wavelength 780 nm	
$\leq 5\%$	$\leq 10\%$	$0.25 \sim 0.6 \mu\text{J}/\text{cm}^2$	$0.25 \sim 0.6 \mu\text{J}/\text{cm}^2$	$\leq 50\text{V}$

Fig. 3 Spectral sensitivity

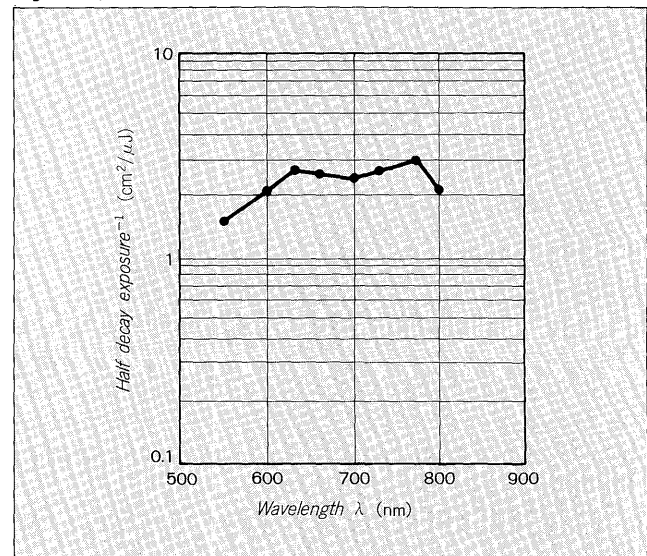
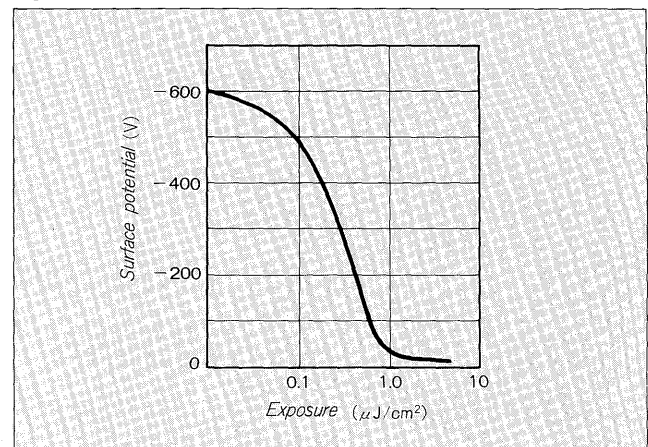


Fig. 4 Dynamic electrical characteristics



substances on the photoconductor surface. Electrical characteristics are deteriorated by changes in the composition of the photoconductive material.

To prevent mechanical characteristics from deteriorating, the Type 8B photoconductor uses material of high wear resistance as the binder resin for the charge transport layer. Figure 6 shows the thickness of the photoconductive layer for two different binder resin conditions during continuous printing.

The Type 8B photoconductor adds an anti-oxidant to the charge transport layer in order to prevent compositional

Fig. 5 Photo response

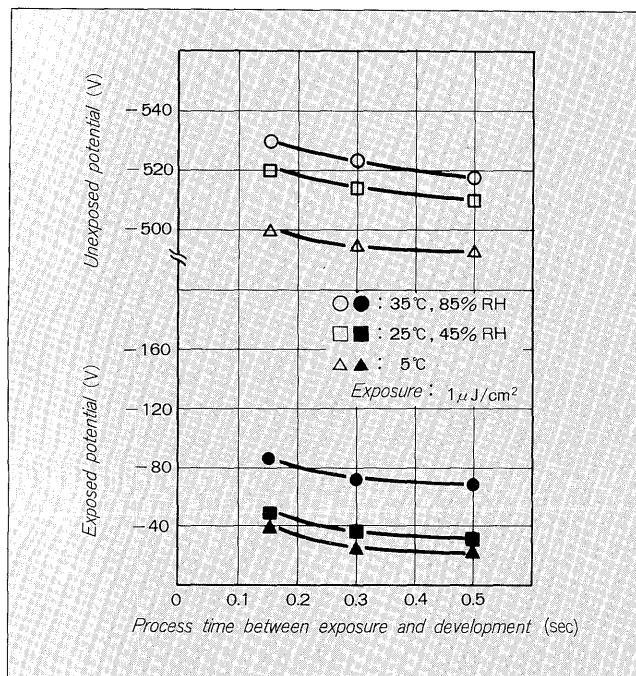
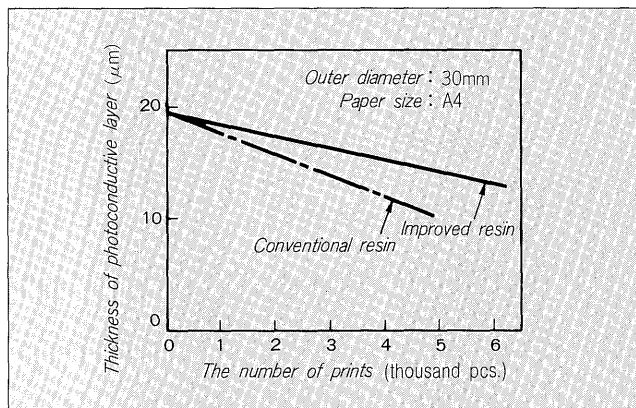


Fig. 6 Film wear by continuous printing



changes. Table 2 shows the electrical characteristics before and after exposure to high density ozone.

### 3.3 Applicability to printer process

The printer process consists of a charging system, an exposing system, a developing system, a transferring system, a cleaning system and an erasing system. Each system will have variations. The photoconductor has to be compatible with them all.

A contact charging system has become of major interest lately. In this system, the photoconductor is charged by applying voltage through conductive parts to the photoconductor surface. There is the possibility that the potential will be centered at a defective area on the surface and dielectric breakdown could occur there. Fuji Electric has developed purification techniques for photoconductive materials and designed optimum coating equip-

Table 2 Electrical characteristics change by ozone exposure

Item	Charge acceptance (V/μA)	Dark decay rate (%)	Half decay exposure (μJ/cm²)	Residual potential (V)
Before exposure	69.8	1.2	0.43	-22
After exposure	70.7	1.4	0.41	-39

Exposure condition: Ozone concentration; 9 ppm  
Exposing time ; 3.5 h

Fig. 7 Dielectric strength

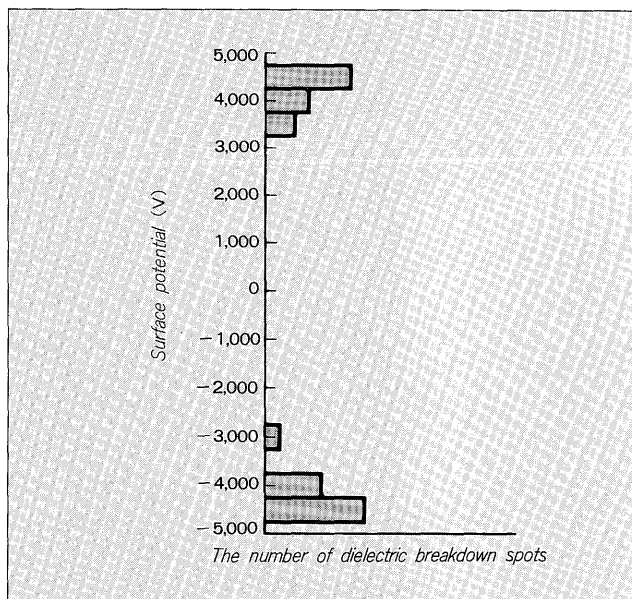


Table 3 Environmental characteristics

Tests	Conditions	Result
High temperature storage	60°C, 60% RH, 1,000 h	No harmful change on the prints and electrical characteristics was made.
High humidity storage	40°C, 90% RH, 1,000 h	
Low temperature storage	-20°C, 1,000 h	
Cyclic characteristics	-20°C, 1h→45°C, 1h x 5 times	

ment, which give Type 8B a very precise surface. Figure 7 shows the dielectric strength of Type 8B. Surface potential of Type 8B in a printer is less than +1,500 V, which means that it has sufficient dielectric strength.

Optimum unexposed potential, optimum exposed potential and optimum half-tone potential depend on each developing system. Photo induced decay characteristics of the photoconductor have to be adjusted to achieve the above potentials. As mentioned before, Type 8B has widely adjustable sensitivity. Additionally, the photo induced decay characteristics of Type 8B are also adjustable by

changing the carrier transport material. Type 8B can be used in all developing systems.

A blade cleaning system is used in low-end and middle-class printers. To obtain higher cleaning performance friction between the blade and the photoconductor surface has to be reduced. For this purpose, a levelizer is added to the charge transport layer, which is also very effective in extending printing life.

### 3.4 Reliability

Page printers are a frequently used hard copy tool in various working environments, especially in Europe and North America. The organic photoconductor should have high reliability under various transport environments, storage environments, and operating environments. *Table 3* shows the environmental characteristics of the Type 8B photoconductor.

## 4. AFTERWORD

For electrophotographic printer it has normally been unavoidable to have periodical maintenance by serviceman. However, it recently becomes easily possible to exchange practically all consumption items by users because of higher performance of organic photoconductor and modularity of printer. The increase in data processing volume and the wide distribution of data communications will need more variety of function of electrophotographic printer in the future. Fuji Electric intends further to develop organic photoconductor with higher performance, higher quality and higher reliability in order to satisfy requirement of advanced electrophotographic printers.

