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PHOTOCONDUCTORS FOR ELECTROPHOTOGRAPHY

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1. FOREWORD

The market of photoconductor for electrophotography is growing steadily together with the increase of electrophotographic equipments. In Fuji Electric, Type 4C (Se/Te) and Type 5 (As_2Se_3) are the main photoconductors for PPC (Plain Paper Copier). As the optical devices and the digital processing technology developed, the use of NIP (Non-Impact Printers) is increasing. Fuji Electric has already developed Type 4D (Se/Te) photoconductor for the medium speed printer. The details of the selenium photoconductor Type 4C, 4D and 5 were reported previously [Fuji Electric Review Vol. 33 No. 1 pp. 34~39 (1987)].

In NIP, not only the demand of the selenium photoconductor but also that of OPC (Organic Photoconductor) is increasing, especially in low speed page printers. Here, we introduce three types of photoconductors shown in *Table 1* for NIP.

Type 7D is multi-layer selenium photoconductor based on As_2Se_3 and has a long printing life. Type 8 and 8B are organic photoconductors. The polarity of Type 8 is positive and Type 8B is negative. So, we are able to match any kinds of developing systems with our photoconductors.

Table 1 Material and uses of various types of photoconductor for NIP

Type	Material	Uses
7D	Se/As/Te	high speed printers
8	organic	low-medium speed printers
8B	organic	low-medium speed printers

2. SELENIUM-ARSENIC-TELLURIUM PHOTOCONDUCTOR TYPE 7D

2.1 Layer structure

Fig. 1 shows the basic layer structure of Type 7D photoconductor. The aluminum substrate is covered with carrier transport layer (CTL) on the outside. The second layer is carrier generation layer (CGL). The surface layer is overcoat layer (OCL). There are interface layers between each layer. All the layers are made by high precision evaporation technique.

Fig. 1 Layered structure operation mode and spectral sensitivity of Type 7D

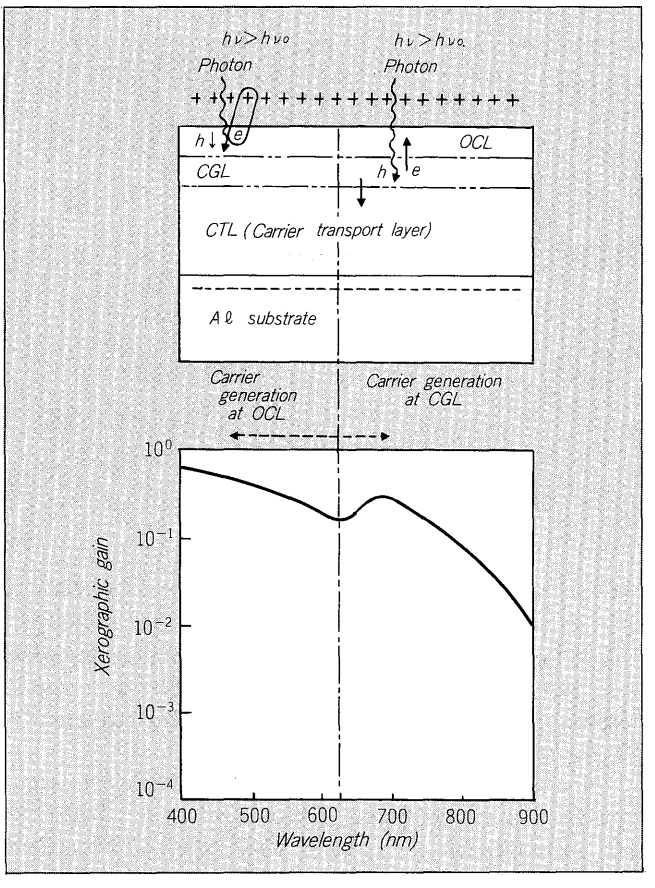


Fig. 1 (bottom) shows spectral sensitivity. As you can see, Type 7D has panchromatic sensitivity (400~800 nm).

2.2 Features and the recommendation for use

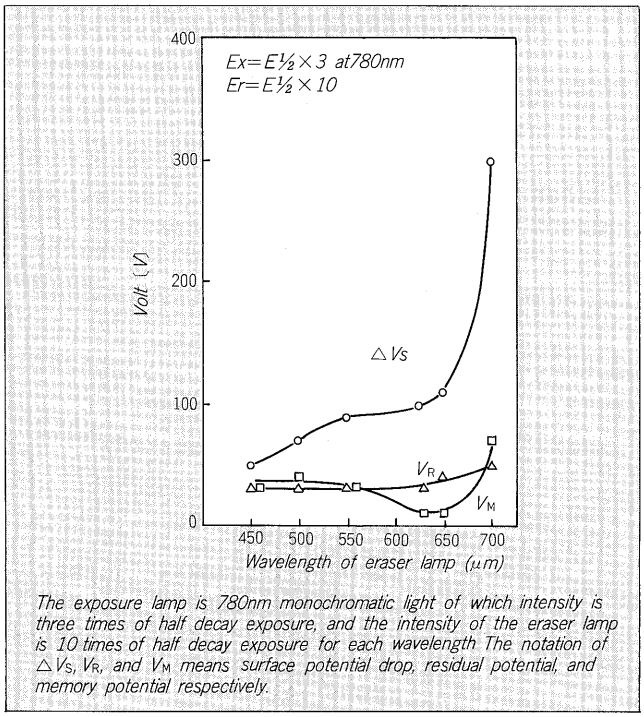
(1) Cyclic stability

Fig. 2 shows the wavelength dependence of cyclic stability for the eraser lamp. Shorter wavelength (< 680 nm) is favorable for light fatigue.

(2) Long printing life

Fig. 3 shows the amount of abrasion. The actual printing life is more than 10^6 prints.

Fig. 2 Wavelength dependence of cyclic characteristics for eraser lamp



The exposure lamp is 780nm monochromatic light of which intensity is three times of half decay exposure, and the intensity of the eraser lamp is 10 times of half decay exposure for each wavelength. The notation of $\triangle V_S$, V_R, and V_M means surface potential drop, residual potential, and memory potential respectively.

2.3 Outline of Type 7D photoconductor

3. ORGANIC PHOTOCONDUCTOR TYPE 8

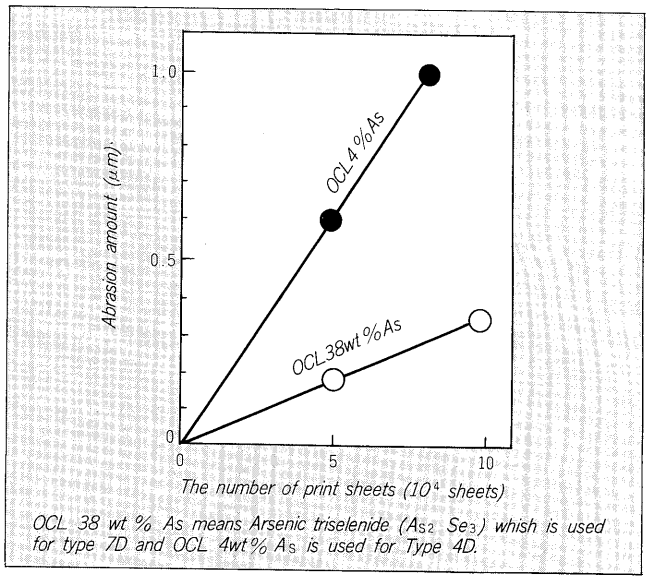
3.1 Layer structure

Fig. 4 shows the basic layer structure Type 8, which is similar to Type 7D. But its OCL has no sensitivity. The carriers are generated only in CGL. All the layers are coated by dipping method.

3.2 Features

(1) Since the polarity of Type 8 is positive, the generation

Fig. 3 The relation between abrasion amount and the number of print sheets



OCL 38 wt % As means Arsenic triselenide (As_2Se_3) whish is used for type 7D and OCL 4wt% As is used for Type 4D.

Table 2 Selenium-Arsenic-Tellurium photoconductor Type 7D outline

Item		Characteristics
Dimension	Diameter Length	φ60 ~ φ262 1000 mm (max)
Structure		Overcoat layer: Arsenic triselenide 4μm Hole injection controlled layer: Selenium-arsen 1μm Charge generation layer: Selenium-tellurium 0.1μm Charge transport layer: Arsenic triselenide 60μm Aluminum substrate
Potential characteristics	Charge acceptance V_0 deviation ΔV_0	±10% (adjustable for development characteristics) less than 100V
	Sensitivity half decay exposure $E_{1/2}$ deviation $\Delta E_{1/2}$ residual potential V_R	 0.6μJ/cm² (at 780 nm) (adjustable by changing tellurium concentration) less than 20% less than 100V (at 780 nm, 5μJ/cm²)
Temperature characteristics	Charge acceptance V_0 Sensitivity $E_{1/2}$	less than 20% (at 5~40°C) less than 20% (at 5~40°C)
Cyclic characteristics	Charge acceptance ΔV_D Sensitivity ΔV_L	less than 10% (250 cycles) less than 10% (250 cycles) dependent of process condition
Environmental characteristics	Storage at high temperature Storage at low temperature Storage at high humidity Storage life	45°C, 1000Hr −20°C, 1000Hr 35°C 65% ~ 25°C 85%, 1000Hr 35°C 65% or less, 18 months
Print life	A4	more than 1×10^5 prints (cut sheet), more than 10^6 prints (serial sheet) [estimated by the print life of Type 5 (As_2Se_3) drum]

Fig. 4 Type 8 layered structure

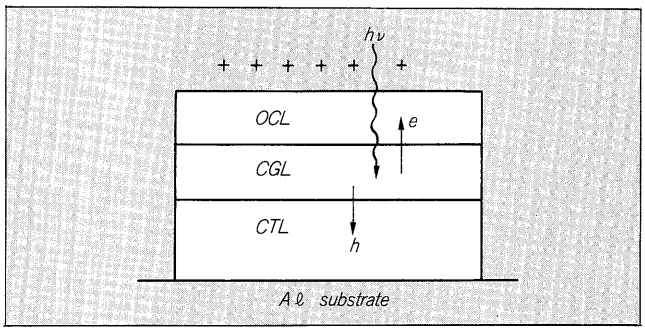


Fig. 5 Spectral sensitivity of Type 8 and 8B

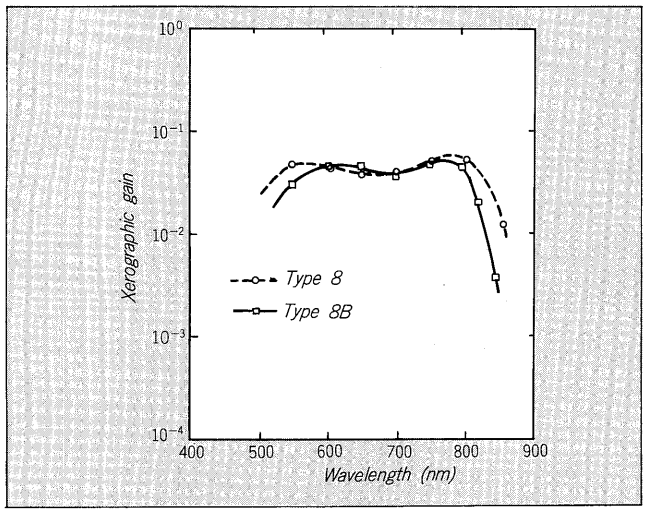


Table 3 Organic photoconductor Type 8 outline

	Item	Characteristics
Dimension	Diameter	ϕ30~120
	Length	360mm (max)
Structure	Substrate	Aluminum
	CTL	CTM+binder: 20 μm (typical)
	CGL	organic pigment+binder: 0.5 μm
	OCL	hard coating material+ binder; 1.0 μm
Potential characteristics	Charge acceptance	35V/μm
	Retentivity	95% (after 1sec)
	Sensitivity (half decay exposure 600 ⇒ 300V)	0.45 μJ/cm² (at 780nm)
	Residual potential (600 ⇒ 100V)	2 μJ/cm² (at 780nm)
Environmental characteristics	Storage at high temperature	45°C, 1000Hr
	Storage at low temperature	–20°C, 1000Hr
	Storage at high humidity	35°C, 60% ~ 25°C, 85%, 1000Hr
	Storage life	35°C, 60% or less, 18 months
Print life	A4	4×10⁴ sheets

of ozone is smaller than negative charge type. That leads the less surface deterioration of the OPC.

(2) *Fig. 5* shows spectral sensitivity. Type 8 has nearly panchromatic sensitivity from 500 to 800 nm and can be also used for PPC with an appropriate filter.

3.3 Outline of Type 8 photoconductor

Table 3 shows organic photoconductor Type 8 outline.

4. ORGANIC PHOTOCONDUCTOR TYPE 8B

4.1 Layered structure

Fig. 6 shows the layer structure of Type 8B photoconductor. The first layer is under coat layer (UCL) and its purpose is the hole blocking. The layers are coated by dipping method but CGL can be made by sublimation method in some cases.

4.2 Features

(1) High sensitivity

Type 8B has higher sensitivity and lower residual potential because of the different design of layer structure. The spectral sensitivity is the same as Type 8 (*Fig. 5*).

(2) Long printing life

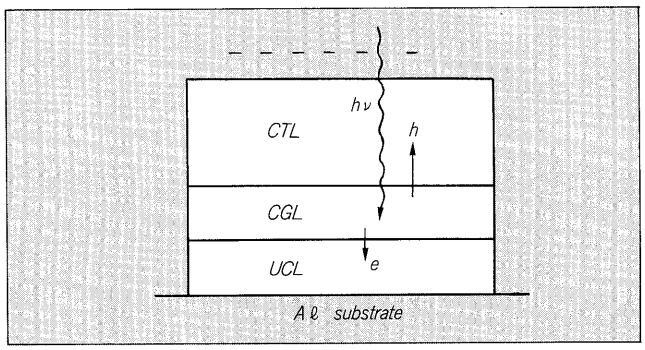
The dark potential decreases together with the abrasion of CTL thickness. Type8B is less abraded. Additionally, the use of the scorotron can compensate the potential drop and make the printing life longer.

4.3 Outline of Type8B photoconductor

Table 4 Organic photoconductor Type 8B outline

	Item	Characteristics
Dimension	Diameter	ϕ30~120
	Length	360mm (max)
Structure	Substrate	Aluminum
	UCL	resin or anodized aluminum (0.1~10 μm)
	CGL	organic pigment+binder: 0.5 μm
	CTL	CTM+binder: 20 μm (typical)
Potential characteristics	Charge acceptance	40V/μm
	Retentivity	95% (after 1sec) or more
	Sensitivity (half decay expore (600V ⇒ 300V)	0.35 μJ/cm² (at 780nm)
	Residual potential (600V ⇒ 50V)	2.5 μJ/cm² (at 780nm)
Environmental characteristics	Storage at high temperature	45°C, 1000Hr
	Storage at low temperature	–20°C, 1000Hr
	Storage at high humidity	35°C, 60% ~ 25°C, 85%, 1000Hr
	Storage life	35°C, 60% or less, 18 months
Print life	A4	8×10⁴ sheets (scorotron use)

Fig. 6 Type 8B layered structure



5. CONCLUSION

We have introduced three types of photoconductors. As mentioned above, these types have favorable characteristics for NIP.

Since the digital processing technology will be grown further more, the demands of these photoconductors will be increased. We continue to make more efforts in the development of the various types of photoconductors.