UDC 681.62.063.3:667.622.3:772.93:681.6

SELENIUM PHOTOCONDUCTOR FOR LASER DIODE PRINTERS

Seizo Kitagawa
Mitsuru Narita
Tatsuo Tanaka

1. INTRODUCTION

Electrophotographic printers, with their advantages of high resolution, high levels of gradation and fastness, are widely used for office automation equipment for the hard copy output of personal computers, word processors, etc. The gas laser, the laser diode (LD) and the light emitting diode (LED) which have both short and long wavelengths (400 through 800 nm) have been used as light sources in electrophotographic printers.

The photoconductor was therefore required to be applicable under these wavelengths. Fuji Electric has developed photoconductors which may be used with various light sources as shown in *Fig. 1*. This paper will introduce the selenium photoconductor (Type 4D) for medium speed LD and LED printers.

2. OUTLINE OF SELENIUM PHOTOCONDUCTOR TYPE 4D

Table 1 Selenium–Tellurium photoconductor Type 4D outline

Item			Characteristics
Dimension	Speed and size		Diameter: $\phi 60 - \phi 120$ (mm) Length: depends on paper size
Structure			Overcoated layer: Selenium-Arsenic 3 μm Carrier generation layer: Selenium-Tellurium 0.3 μm Carrier transport layer: pure-Selenium 50 μm Aluminum substrate (JIS A 3003 Aluminum alloy)
Electrical Characteristics	Charge acceptance	V_0	V ± 10% (depends on development characteristics)
	deviation	ΔV_0	less than 100 V
	Sensitivity		
	half decay exposure	$E_{1/2}$	0.6 μJ/cm² (at 780 nm) (available by tellurium concentration)
	deviation	$\Delta E_{1/2}$	less than 20%
	residual potential	V_R	less than 100 V (at 780 nm, 5 μJ/cm²)
Temperature Characteristics	Charge acceptance	V_0	less than 20% (at 5–40°C)
	Sensitivity	$E_{1/2}$	less than 20% (at 5–40°C)
Cyclic Characteristics	Charge acceptance	ΔV_D	less than 10% (250 cycle) ┐ depend on process condition
	Sensitivity	ΔV_L	less than 10% (250 cycle) ┘
Environmental Characteristics	Storage at high temperature		45°C 1,000h
	Storage at low temperature		–20°C 1,000h
	Storage at high humidity		35°C 65%~25°C 85% 1,000h
	Storage life		35°C 65% or less 18 months
Durability	Print life (letter)		10^6 prints (more than 3×10^6 prints in high speed printer)

Fig. 1 Spectral sensitivity for exposure source of printers

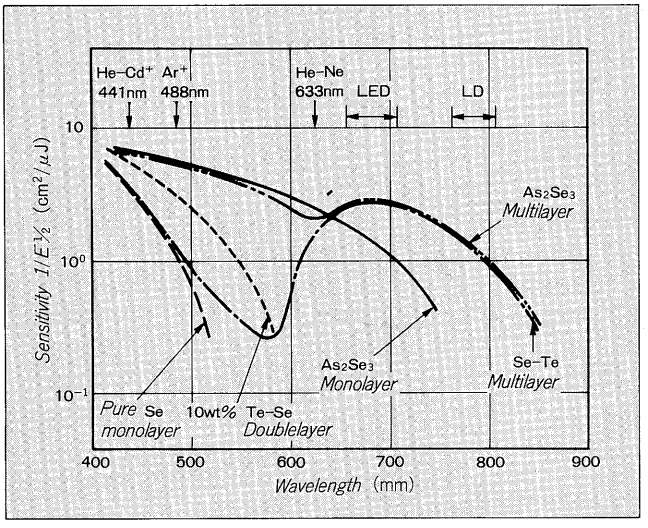


Fig. 2 Layer structure

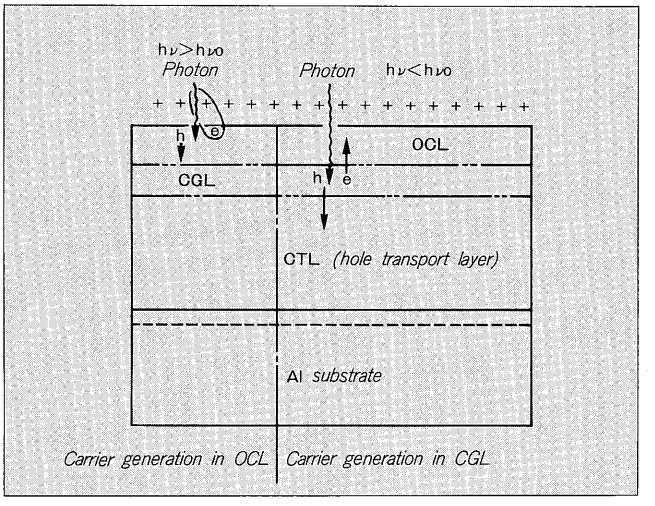
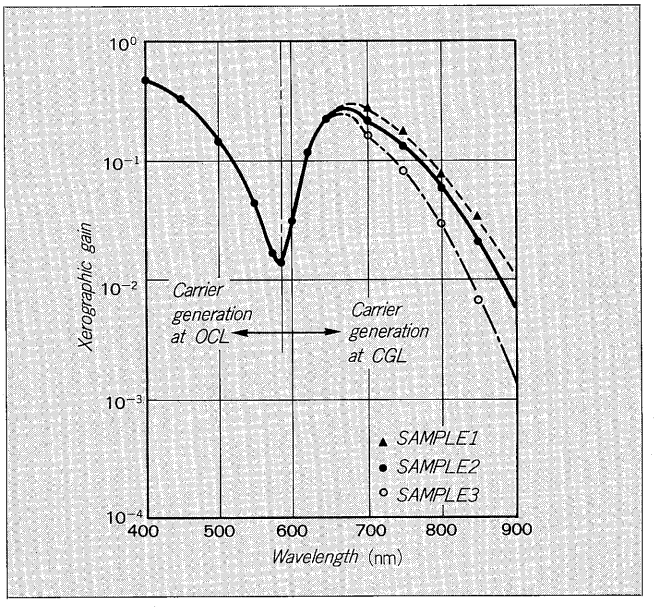


Fig. 3 Spectral sensitivity



The outline, the layer structure and operating modes of the selenium photoconductor Type 4D are shown in *Table 1, Fig. 2* and *Fig. 3*, respectively.

2.1 Layer structure

Figure 2 shows the basic layer structure of the Type 4D photoconductor. The aluminum substrate is covered with a carrier transport layer (CTL) on the outside. The basic layer structure consists of CTL (60 μm), CGL (0.3 μm) and OCL (3 μm) although, strictly speaking, there are five layers. *Figure 3* shows how the xerographic gain is affected by the wavelength. As can be seen, there are two peaks separated at incident wavelength = 580 nm; these are probably due to the structure. Carriers are generated in different layers according to the wavelength of the incident photon.

2.2 Operating mode

1) Short-wavelength mode

At wavelength less than 580 nm, incident photons are absorbed by the OCL and carriers are generated near its surface. Among them, electrons are combined with positive holes caught in deep traps of the surface by corona discharge. The remaining positive holes pass through OCL, CGL and CTL, and reach the aluminum substrate. *Figure 3* shows the spectral characteristics for short-wavelength light, which are the same as for those of OCL only.

2) Long-wavelength mode

If incident photons of wavelength greater than 580 nm are received, carriers are generated in CGL. At wavelength less than 650 nm, photons are partly absorbed by OCL. The generated carriers are recombined quickly and cannot become free carriers (geminate recombination). The remaining photons which pass through create free carriers in OCL. At wavelength greater than 650 nm, most of the photons are absorbed not by OCL but by CGL combined with positive holes on the surface, and disappear. The positive holes enter CTL from CGL then reach the aluminum substrate.

3. CHARACTERISTICS OF SELENIUM PHOTOCONDUCTOR TYPE 4D

3.1 High sensitivity and cyclic stability

Spectral sensitivity and charge characteristics compared with other photoconductors are shown in *Fig. 4* and *Fig. 5*, respectively.

3.2 High durability (selenium-arsenic overcoated layer)

The difference of the thermal degradation characteristics by the composition of overcoated layer is shown in *Fig. 6*.

Fig. 4 Spectral sensitivity

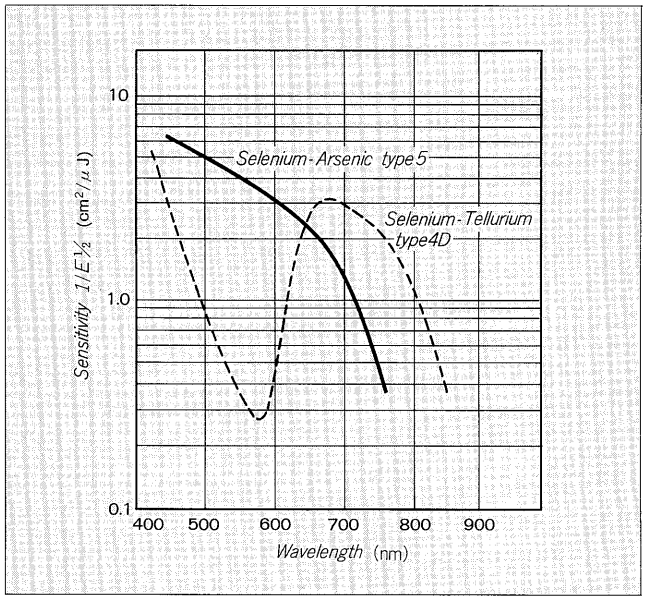


Fig. 5 Charge characteristics

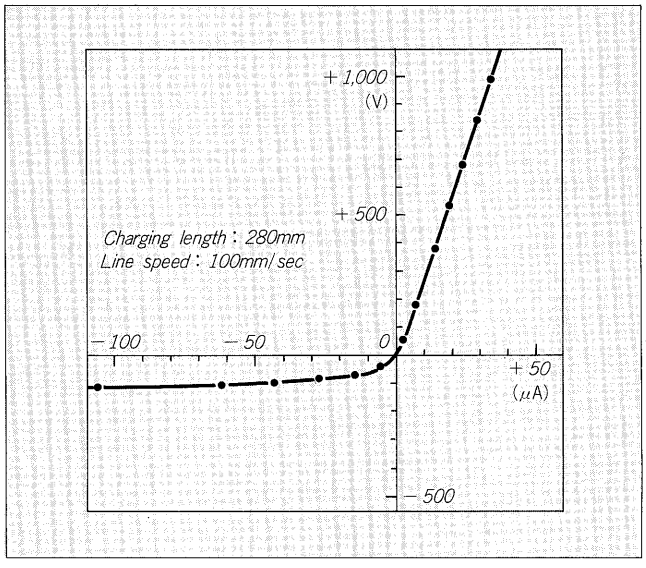


Fig. 6 The difference of the thermal degradation characteristics by the composition of overcoated layer (the drum current change by storage test at a high temperature)

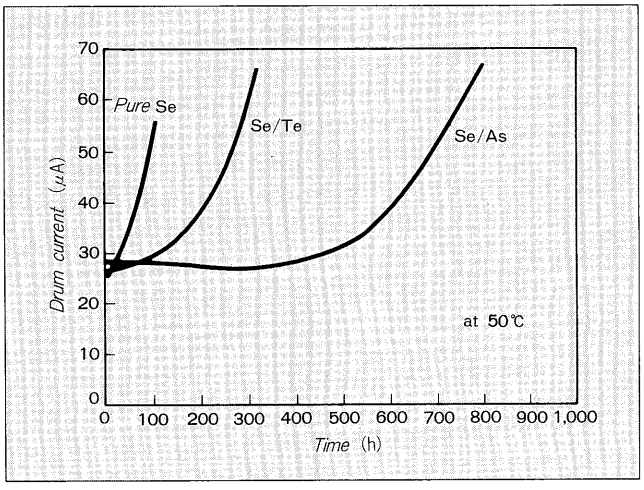
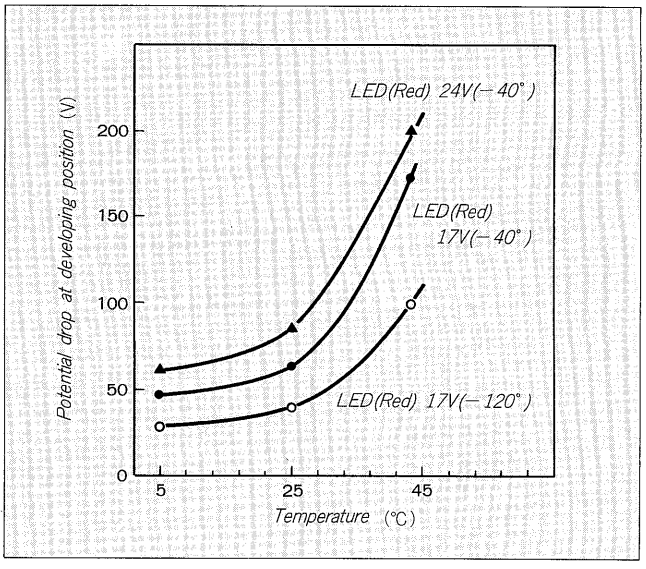


Fig. 7 The temperature dependence of the potential drop at developing position by eraser intensity and its position (angle from main charge in counterclockwise)



3.3 Process design for erase lamp and temperature dependence (optimum design by our process simulator)

The relation between operation stability and erase lamp is shown in *Fig. 7* (measured by our process simulator).

4. AFTERWORD

Fuji Electric has introduced the selenium photoconductor Type 4D. As mentioned above, this photoconductor has desirable characteristics for electrophotographic equipment such as NIP (Non Impact Printers), and is being used in the world wide market. Since it is expected that the market for electrophotographic equipment will expand further and that the technology will become more varied and complex, the technical demands on photoconductors will increase even more.

Fuji Electric will continue to make efforts to develop various types of photoconductors utilizing selenium and organic materials.