OPCs

(Organic Photoconductors)

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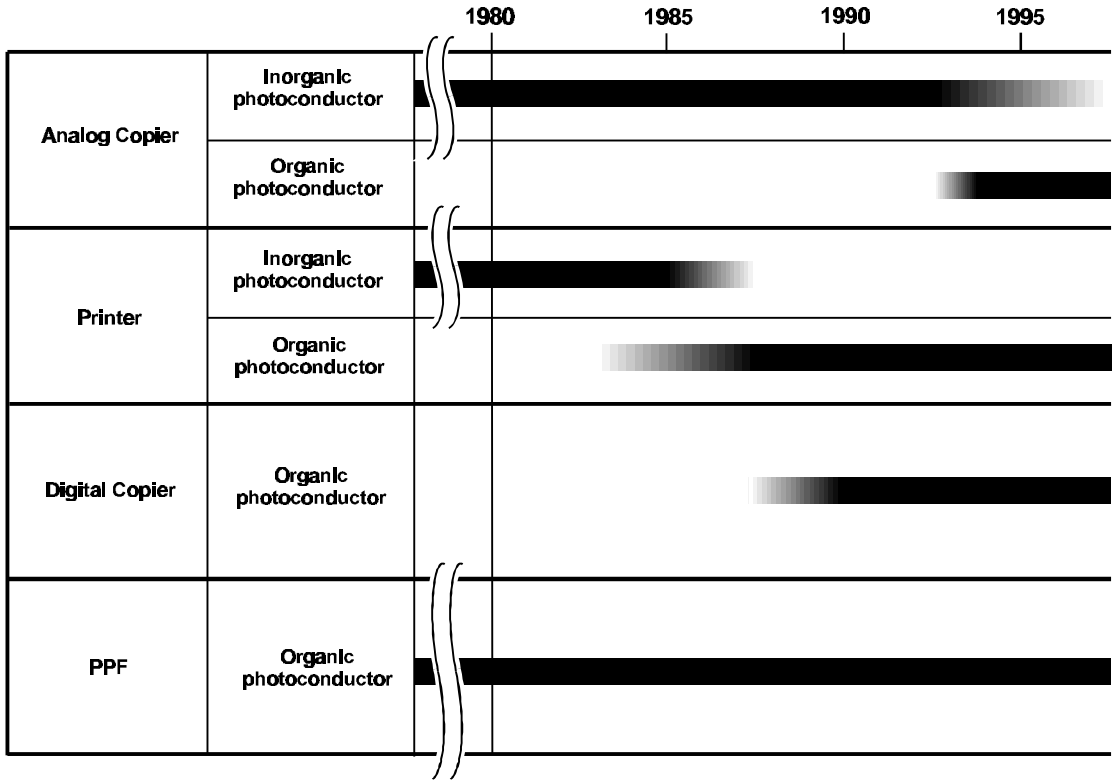
1. OUTLINE

In most copiers or plain paper facsimile machines, a photoconductor transfers an image of the original to the output of a printer.

Generally, our products use two types of photoconductors. One type is an inorganic photoconductor, made of selenium, that was used in the past for analog copiers. The other type is an organic photoconductor (OPC) that is used for analog and digital copiers, plain paper facsimiles, and laser printers. Recently, all such products use OPCs instead of inorganic photoconductors.



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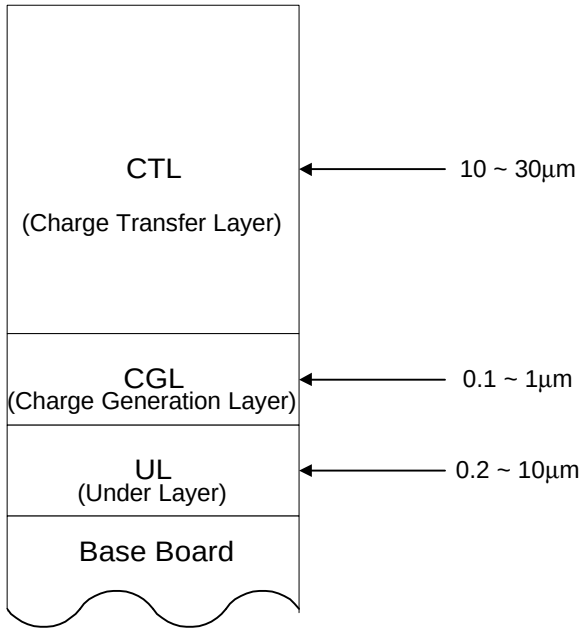
2. COMPOSITION AND FUNCTIONS

2.1. Composition



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An OPC consists of a CTL (Charge Transfer Layer), CGL (Charge Generation Layer), UL (Under Layer), and a base board.

2.2. Function and Material of Each Layer

Layer	Main Function	Material
CTL	The charge generated in the CGL is transmitted through this layer to the surface of the photoconductor.	Organic additive Plastic binder
CGL	Generates the charge from the absorption of light.	Azo pigment Plastic binder (Analog OPCs have a different pigment from digital OPCs; see page 5-3 for more details. In analog OPCs, The pigment gives analog OPCs a dark blue color, and digital OPCs a green color.)
UL	Prevents positive charges generated in the CGL from going to ground.	Organic or inorganic additive Plastic binder
Base board	Develops the counter charge to the charge developed on the CTL.	Aluminum drum or nickel belt

3. STYLES

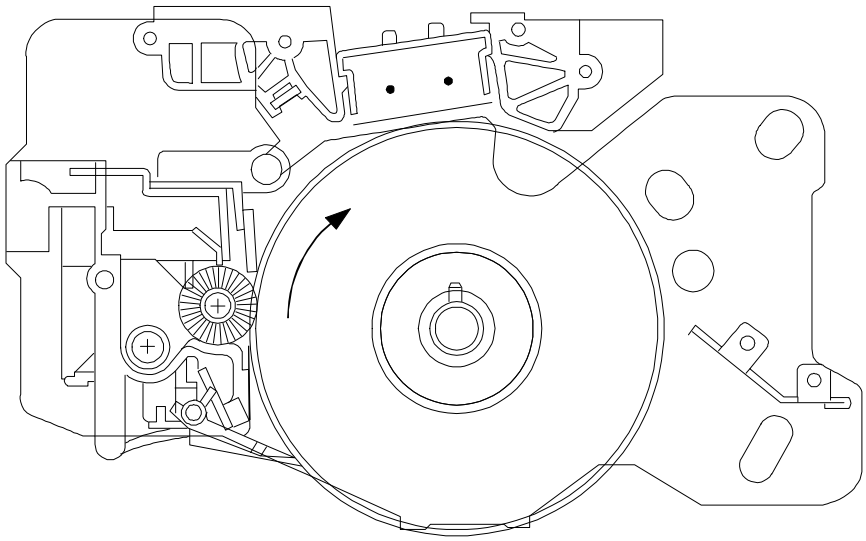
3.1. Drum and Belt

There are two types of OPCs used today: the drum type [A] and the belt type [B].

The drum type has a base of aluminum or nickel. It is usually used in copiers, as well as laser facsimile machines and laser printers.

The belt type has either a film of polyester or a nickel belt. The nickel belt has a bond seam, while the polyester film is seamless. The belt type is used in laser facsimile machines and laser printers. It is not normally used in copiers.

[A]



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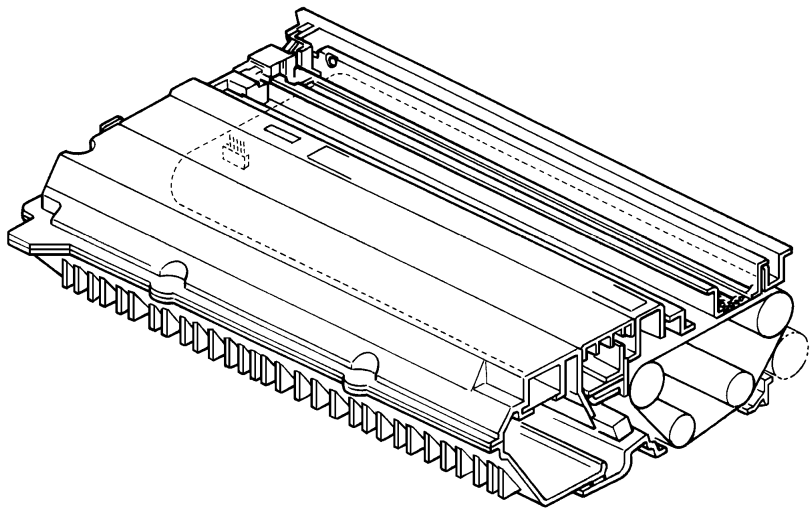

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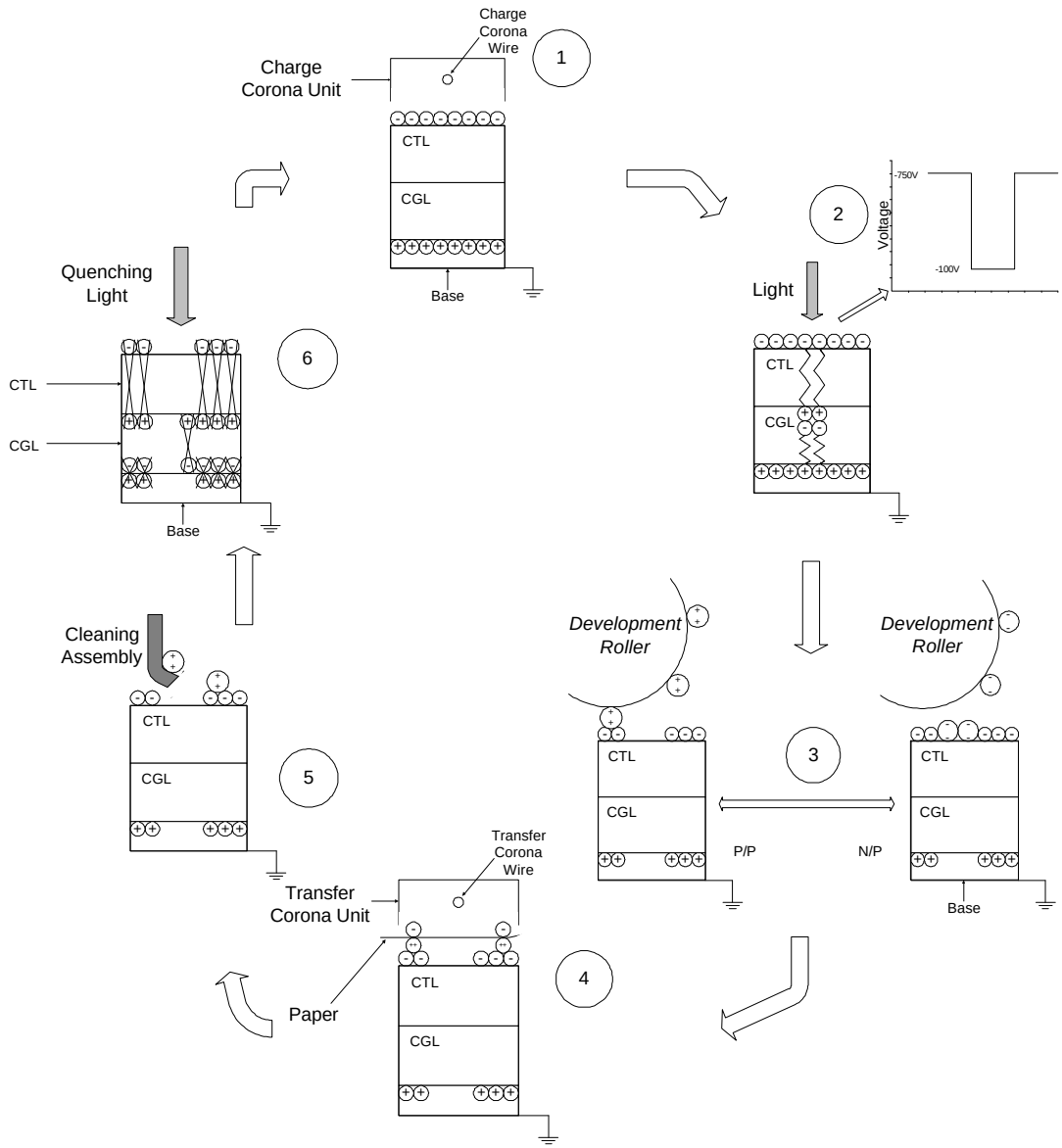
4. COPY CYCLE

4.1. Overview

The OPC transfers an image of the original to the output paper (copy or fax). It does this during the copy cycle.



4.2. The Steps of the Copy Cycle

The following is a step-by-step description of how the OPC functions during the copy cycle.

1. Charge
   The transfer corona wire applies a negative charge to the surface of the CTL (about -750 V). Due to a capacitor-like effect, a positive charge is produced on the base.

2. Exposure
   Light (either reflected fluorescent light or laser light) strikes the OPC. This light causes the CGL to generate positive and negative charges. The positive charges are attracted to the CTL's surface negative charge. The negative charges are attracted to the CGL's surface positive charge.

   As a result, where light has struck the CTL, the CTL's surface voltage drops to about -100V.

Note: When exposure is done with a fluorescent lamp, the reflected light corresponds to the white areas of the original. When exposure is done with a laser diode, the light corresponds to the black areas of the original, in most machines.
Exposure, therefore, creates a charged latent image of the original on the surface of the OPC.

3. Development
   The development roller applies charged toner to the OPC that will adhere to the latent image.

   In Positive/Positive (P/P) development, the development roller applies positively charged toner to the OPC. The toner is attracted to the negative areas where light has not contacted the OPC.

   In Negative/Positive (N/P) development, the development roller applies negatively charged toner to the OPC. The toner is attracted to the relatively positive areas where light has contacted the OPC.

   P/P development is used when the light reaching the OPC corresponds to white areas of the original. P/P development is used when exposure is done with a fluorescent lamp, and in some earlier laser engines that used the "write-to-white" system.

   N/P development is used when the light reaching the OPC corresponds to black areas of the original, as in most laser-based print engines.

4. Transfer
   The transfer corona wire develops a charge of opposite polarity to the toner (negative in P/P development, positive in N/P development). The wire applies this charge to the back of the output paper. This charge, therefore, will attract the toner (attached to the OPC in the latent image of the original) to the paper. The paper then goes on to the fusing unit where the toner is fused to the paper.

5. Cleaning
   The cleaning assembly removes any residual toner on the OPC after transfer.

6. Quenching
   When the quenching light is applied to the OPC, it causes the CGL to generate positive and negative charges (as in the exposure step). These charges similarly cause the voltage on the surface of the CTL to drop to about -100 V, except that in quenching, the entire surface of the OPC is exposed. Therefore, the quenching lamp removes the high negative potential remaining from the previous stages of the copy cycle. This readies the OPC for the next copy cycle.

5. OPC CHARACTERISTICS

5.1. General Characteristics

These characteristics include:

1. The ability to accept a high negative electrical charge in the dark. (The electrical resistance of a photoconductor is high in the absence of light.)
2. The ability to dissipate the electrical charge when exposed to light. (Exposure to light greatly increases the conductivity of a photoconductor.)
3. The ability to dissipate an amount of charge in direct proportion to the intensity of the light applied. Therefore, the greater the intensity of light applied to the photoconductor, the smaller the voltage remaining on the OPC.
4. An OPC is less sensitive to changes in temperature than selenium-based drums (also known as F type drums).
5. An OPC is less sensitive to changes in rest time (in other words, it is not so sensitive to light fatigue as F type drums). It is therefore unnecessary to compensate development bias voltage for variations in rest time.
6. Lower cost than an F type drum.
7. No need for special disposal considerations.

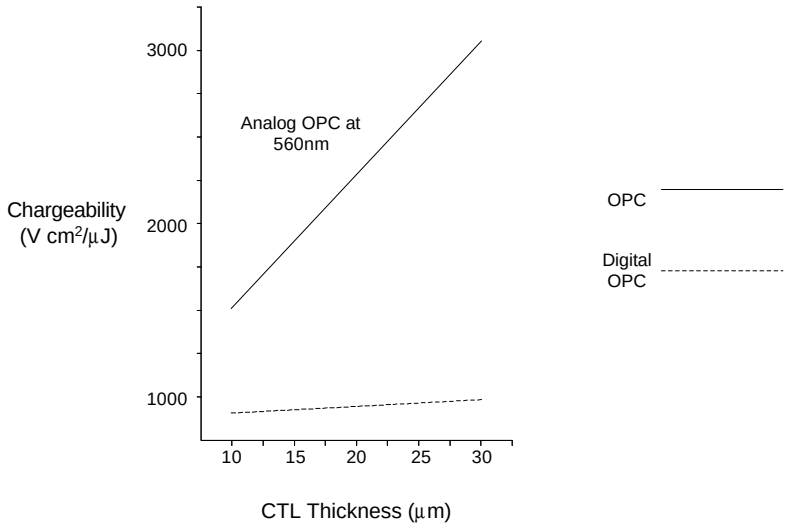
5.2. Special Characteristics

5.2.1. Deterioration in OPC Thickness

Some abrasive actions in the copy cycle gradually reduce the thickness of the CTL over time. These actions include cleaning, development (application of the ferrite carrier by the development roller), and separation (the pick-off pawl separating the page from the OPC).

This reduced thickness results in a decrease in the capacitor effect on the OPC (resulting in reduced chargability). This will affect the chargeability of analog OPCs and digital OPCs at different rates. (See the chart below.)

The chargeability of the analog OPC decreases much more rapidly than that of the digital OPC. For the same amount of reduction in CTL thickness, therefore, the copy quality of the analog OPC decreases much more rapidly than for digital OPCs.



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Analog OPCs use positive/positive development. Since positively charged toner is applied to the OPC, the amount of negative voltage the OPC can accept is very important to copy quality.

Digital OPCs use negative/positive development. Since negatively charged toner is applied to the OPC, a decrease in the OPCs negative voltage will not have such a drastic effect on copy quality. (It will, however, cause a "dirty" background appearance.)

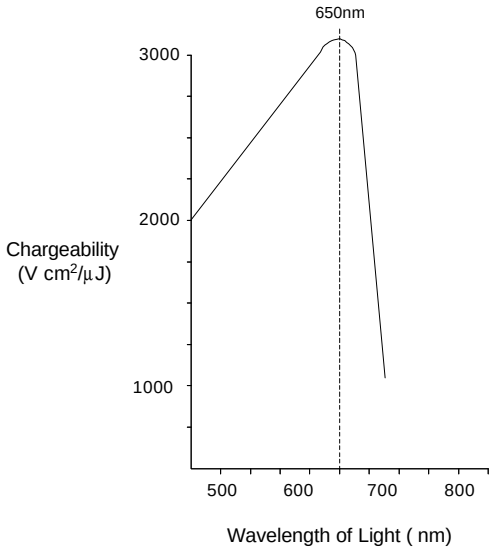
Note: In the past, positive/positive development has sometimes been used with digital OPCs. In this case, the laser exposure corresponds to the white areas of the original. However, in most printouts, there are many more white areas than black areas, so positive/positive development leads to a reduced OPC lifetime.

5.2.2. Wavelength of Light

The wavelength of fluorescent light is 450 nm ~ 650 nm. The wavelength of laser light is 780 nm. The charge generation material (CGM) for analog and digital OPCs is designed differently due to these different wavelengths. The difference is most easily observed in the colour of pigmentation

The CGM in an analog OPC is designed for maximum power output (chargeability) at 450 nm ~ 650 nm (depending on the machine). This will allow the OPC to work optimally with reflected fluorescent light.

The CGM in a digital OPC is designed for maximum power output (chargeability) at 780 nm. This will allow the OPC to work optimally with laser light.



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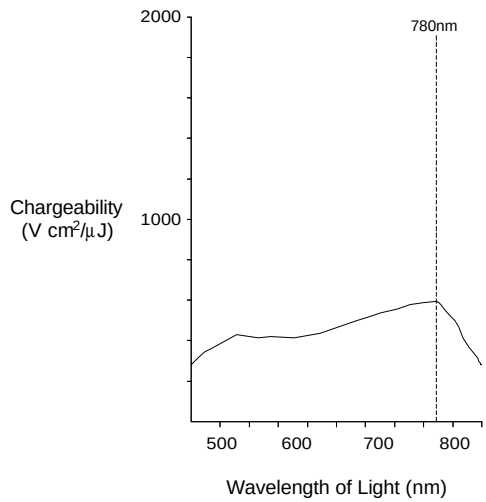
Analog OPCs

Chargeability in relation to the wavelength of light applied.



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Digital OPCs

Chargeability in relation to the wavelength of light applied.

5.3. Differences between Analog and Digital OPCs

Item	Analog OPCs	Digital OPCs
CGL	Contains a material that responds to the wavelength of white light, such as light from a fluorescent lamp.	Contains a material that responds to the appropriate laser wavelength.
CTL	The CTLs are also different, to match the CGL that is used.	
CTL Thickness vs Chargeability	If the CTL thickness is reduced, the chargeability is also reduced.	The same as for Analog OPCs. The chargeability does not, however, decrease as rapidly as in analog OPCs.
Development Method	Positive/positive only.	Negative/positive or positive/positive can be used. Negative/positive is mainly used.
Image Transfer	The image transfer charge has the same polarity as the charge corona unit.	The image transfer charge has the opposite polarity as the charge corona unit.

6. EFFECTS OF ENVIRONMENTAL FACTORS

6.1. Light

The CGL generates positive and negative charges when the OPC is exposed to light. These charges flow normally (see page 4-1) when the OPC is in the machine. However, exposing the OPC to light after it has been removed from the machine also causes the CGL to generate charges. Since there is no path for current flow, these charges may remain in the CGL. When the OPC is put back in the machine, these stray charges will result in decreased chargeability and reduced copy quality.

OPC exposure to normal fluorescent lighting for 5~20 minutes will generate stray charges. It is important, therefore, to cover the OPC with paper when removing it from the machine. If the OPC has been inadvertently exposed to light, it is very important to shield it from any additional light for 10~15 minutes *before* making a copy. This will allow the charges to dissipate naturally. If a copy is made before doing this, the stray charges will remain in the OPC. It will take 1~2 months for the OPC to return to a normal condition. During this time the residual voltage will be high and copy quality will be reduced.

6.2. Temperature

The melting temperature of the CTL is 60 °C ~ 70 °C. Take care (especially during warehouse storage) not to exceed this temperature. Packing materials may stick to the melting CTL. This will destroy the OPC.

6.3. Gases

Certain gases will affect the OPC.

Ozone

Ozone (O_3) is produced in most machines by the charge corona unit and the transfer corona unit. Usually, a machine which uses these units is equipped with an ozone fan and ozone filter. This equipment removes the ozone from the machine.

O_3 will reduce the chargability of the OPC. O_3 can affect both analog and digital OPCs.

Ammonia and Nitrogen Oxides

Ammonia (NH_3) and nitrogen oxides (NO_X) may reach the OPC from the outside environment.

NH_3 can affect analog OPCs by removing negative charges from the CTL (as the analog CTL material easily releases negative charges). This will reduce chargeability and copy quality.

NO_X can affect digital OPCs by adding negative charges to the CTL (as the digital CTL material easily accepts negative charges). This will reduce chargeability and copy quality.

6.4. Dust and Oil

Dust and oil should be removed from the OPC. Dust and oil prevent toner from adhering to the OPC. This reduces copy quality.

Remove oil with a dry or slightly dampened cloth. Be sure to wipe the OPC dry after applying a dampened cloth (use a clean dry cloth). It is important that no water remains on the OPC.

Remove dust with a dry cloth.

Note: Never apply alcohol to the OPC.