A Study of 1-dot Latent Image Potential

Kouichi Aizawa, Motohiro Takeshima, Haruo Kawakami
Fuji Electric Imaging Device Co., Ltd.
Matsumoto, JAPAN

Abstract

In order to make high resolution electrophotographic images, it is useful to know how well the 1-dot latent image potential is formed on the photoconductor. This report describes a new method of measuring micro-area surface potential profiles and analyzing the latent images. The results for 1-dot latent image potentials of negatively charged double layer organic photoconductors (OPC) and positively charged single layer OPC are presented. The dependencies on film thickness, photosensitivity and charge mobility are examined.

Introduction

In electrophotography, for example color printers or multifunctional digital printers, high quality images, especially high resolution images are required. It is useful to know how well the 1-dot latent image potential is formed on the surface of photoconductor. Several theoretical studies[1,2] and a high resolution surface charge measurement method[3] have been reported in the literature. We have developed a new measurement system for assessing latent images on photoconductor drums. This method reveals new information on the correlation between latent image and photoconductor material.

Measurement Principle

Figure 1 shows the measurement principle[4] of micro-area surface charge. A transparent electrode is set opposite to the charged photoconductor that contains 1-dot latent image. A laser beam with 780nm wavelength is used as the detection light to further expose the imaged photoconductor. The discharge of photoconductor induced by the detection laser beam changes the capacitance between the electrode and the photoconductor surface, which can be measured by the induced current. The exposure intensity of the detection laser is large enough to fully discharge the surface potential, and therefore, the induced current is proportional to the surface potential. Different induced currents are measured when the detection laser scans across a potential distribution on the photoconductor. Figure 2 shows the relation between the induced current and the surface potential. Surface potentials are deduced from the measured currents using this relation.

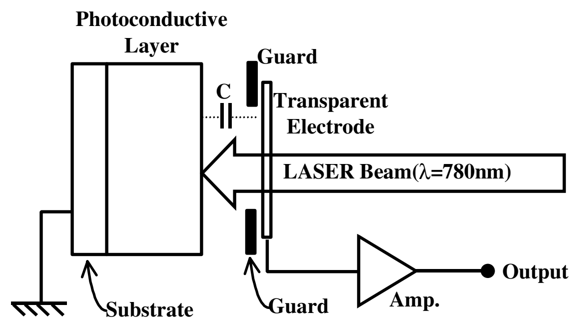

Figure 1. Principle of micro-area charge measurement

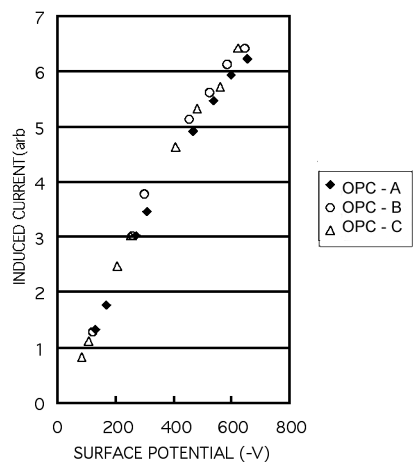

Figure 2. Correlation of induced current and surface potential

Measurement System

Figure 3 shows the geometry of the measurement system, consisting of the charging stage, laser scanner unit (LSU), and the measurement stage. Laser beam with 80 micron diameter at the position of 13.5% maximum intensity from the LSU is used to draw 1-dot lines. The diameter of the detection laser beam is 10 micron, thus, micro-area information of 1-dot latent image can be examined.

Photoconductor is charged uniformly and exposed to 1-dot line of LSU to form latent images. At the measuring stage the photoconductor is rotated at 30 micron steps. At each step, the photoconductor is exposed to the detection laser and a measurement of latent image potential is taken.

Figure 4 shows the definition of width and depth of latent image for this analysis.

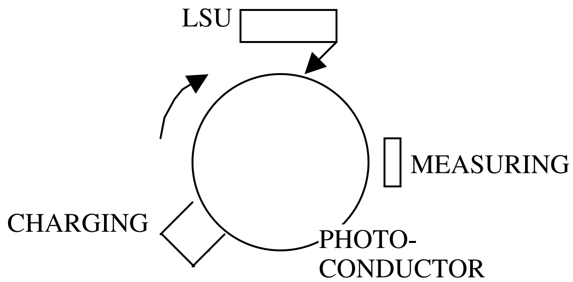

Figure 3. Latent image measurement system

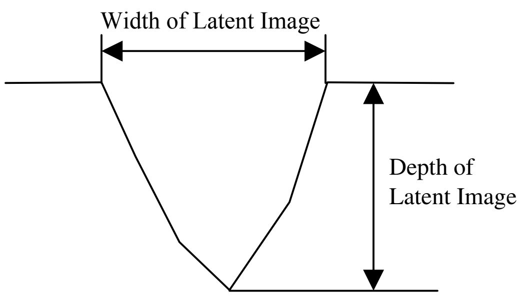

Figure 4. Definition of width and depth of latent image

Experimental Results

LSU Exposure Dependency of Latent Image

The variation of latent image profiles with exposure power is shown in figure 5. The sample is a negatively charged dual layer OPC having the photosensitivity listed in Table 1.

A latent image of 210 micron width and 210V depth is formed with 0.1mW LSU exposure. Increasing the LSU power extends the latent image width and increases the latent image depth. At 0.28 mW exposure a latent image of 270 micron width and 260V depth is obtained. LSU exposure power dependency of latent image width and depth are shown in figure 6.

The intensity at the tail of laser beam profile increases with the exposure power. This accounts for the observed increase of the width and depth of latent images, and confirms the reliability of the measurement principle.

Table 1. Photosensitivity of negatively charged OPC

OPC	E300 (mJ/m^2)	E100 (mJ/m^2)
Negative H	0.9	2.0

E300 : Required exposure to decay from –600V to –300V
E100 : Required exposure to decay from –600V to –100V

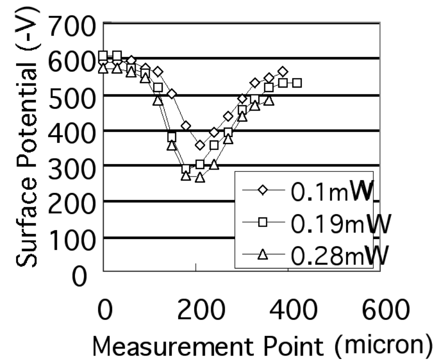

Figure 5. Exposure dependence of latent images

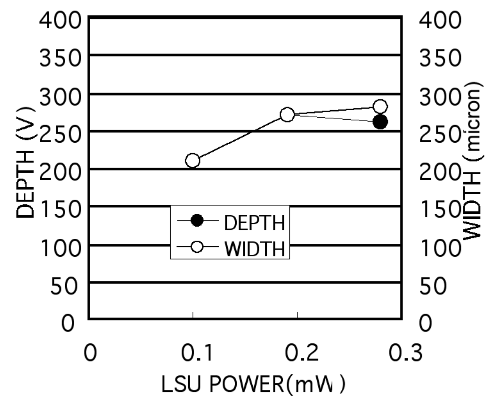

Figure 6. LSU exposure power dependency of latent image width and depth

Film Thickness Dependency of Latent Image

In order to discuss the difference between negatively charged dual layer and positively charged single layer OPC, the film thickness dependency of latent images is examined. The OPC samples are of medium sensitivity. The photosensitivity and thickness of the samples are shown in Table 2. Test results are shown in figures 7 and 8 for negatively and positively charged OPC, respectively.

In negatively charged OPC, the thinner sample (18 micron) yields a latent image of 180 micron width and 120V depth. But as the film thickness increases, the latent images become wider. This is consistent with the observation that thicker dual layer OPC has poorer image resolution.

Table 2. Photosensitivity and Thickness

OPC	E300 (mJ/m^2)	E100 (mJ/m^2)	Film Thickness (micron)
Negative C	3.8	8.2	24
Positive C	2.2	7.7	22

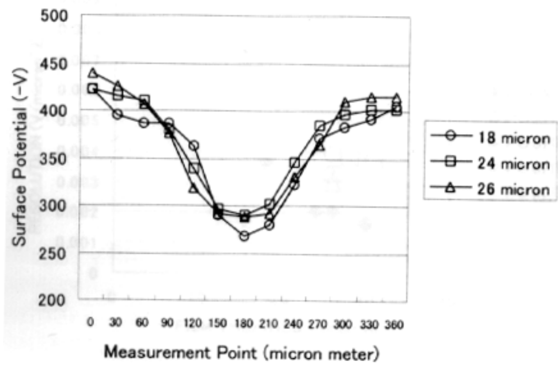

Figure 7.Film thickness dependency of latent images on negatively charged OPC

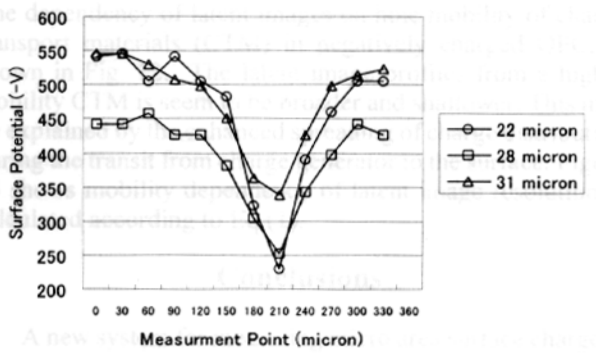

Figure 8. Film thickness dependency of latent images on positively charged OPC

Positively charged OPC, especially the 22 micron sample yields a sharp latent image, which has 180 micron width and 250V depth. The equally sharp latent images are observed even increasing the thickness to 31 micron. This result can be explained by the fact that in positively charged OPC photo-induced carriers are generated near the surface. It also accounts for the weak dependence of image resolution on the thickness in positively charged single layer OPC.

Sensitivity Dependency of Latent Image

Latent image profiles on three positively charged OPC samples with different sensitivities are shown in figure 9. The photosensitiviy and thickness of the samples are listed in Table 3. The changes in the depth and width, as shown in figure 10, are small even the sensitivities are varied from 6.8mJ/m^2 to 14.7mJ/m^2.

Table 3. Photosensitivity and Thickness of Positively Charged OPC

OPC	E300 (mJ/m^2)	E100 (mJ/m^2)	Film Thickness (micron)
Positive A	3.3	14.7	25
Positive B	2.8	10.1	25
Positive D	2.1	6.8	25

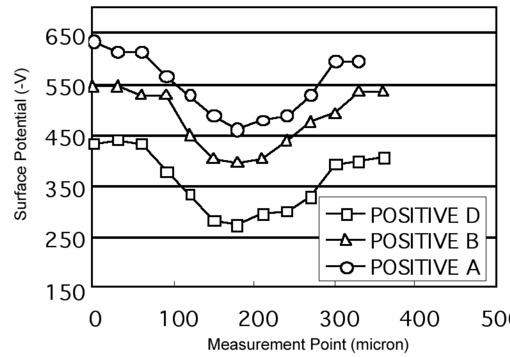

Figure 9. Sensitivity dependency of latent images on positively charged OPC

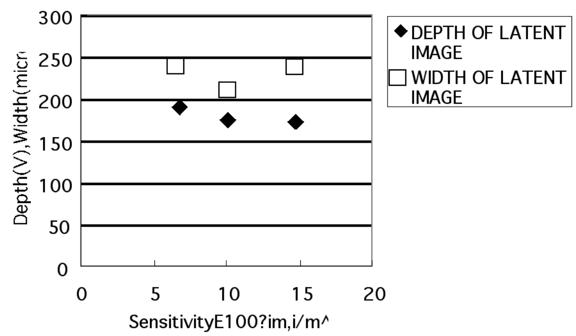

Figure 10. Sensitivity dependence of latent images

The authors propose to quantify the resolution of a latent image by a value R defined as follows:

$$R = D / W^2 \qquad (1)$$

where D is the depth and W is the width of a latent image. Calculated R values are plotted versus film thickness in figure 11. Negatively charged OPC shows strong dependency of R on film thickness, with R decreasing to under 0.002 for thickness over 26 micron. Positive OPC shows high R values even in large thickness.

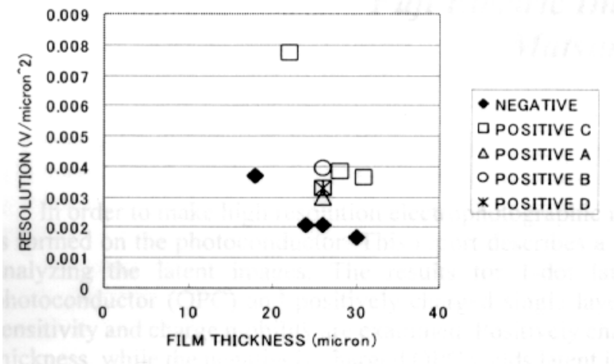

Figure 11. Film thickness dependency of resolution R

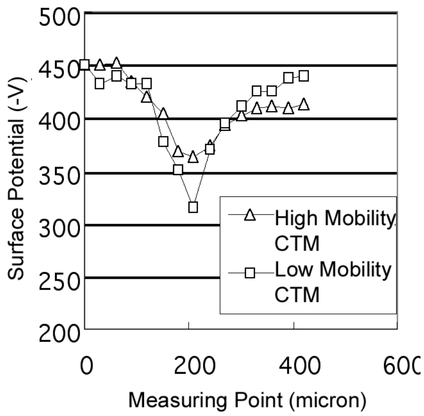

Figure 12. CTM dependency of latent image profile

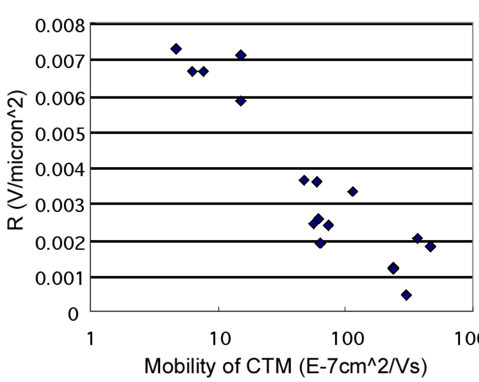

Figure 13. Mobility dependency of latent image resolution

Mobility Dependency of Latent Images

The dependency of latent images on hole mobility of charge transport materials (CTM) in negatively charged OPC, is shown in Fig. 12. The latent image profiles from a higher mobility CTM is seem to be broader and shallower. This may be explained by the enhanced spreading of charge distribution during the transit from charge generator to the surface. Figure 13 shows mobility dependency of latent image resolution R calculated according to Eq.(1).

Conclusions

1. A new system for measuring micro area surface charge is developed and latent image profiles are evaluated at 30 micron steps.
2. Negatively charged dual layer OPC shows deterioration of latent image as the film thickness is increased.
3. Positively charged single layer OPC shows weak dependency of latent image profile on film thickness and shows sharp latent image even with a large thickness.
4. Decrease of latent image resolution is measured in high mobility CTM in negatively charged OPC.

References

1. I. Chen, *J. Imaging Sci. and Technol*. **34**, 15(1990); **35**, 365 (1991); **39**, 302 (1995)
2. Y. Watanabe, et al, *IS&T's NIP16:International Conference on Digital Printing Technology*, 822(2000)
3. E. J. Yarmchuk and G. E. Keefe , *J. Appl. Phys*. **66**, 5435 (1989)
4. C. W. Lin and T. Nozaki, *Proceedings of IS&T's 11th International Congress on Advances in Non-Impact Printing Technologies*, 138 (1995)

Biography

Kouichi Aizawa received the B.E. and M.E. degrees from Yokohama National University, Kanagawa, Japan in 1981 and 1983, respectively. Since 1983 he has been working for Fuji Electric Co., Ltd. and Fuji Electric Imaging Device Co., Ltd. His work has primarily focused on the development of new materials for photoconductor. He is a member of the Imaging Science of Japan and the Japan Society of Applied Physics.