

Analysis of Traps in OPC from the Dependence of Corona Charging Curve on Thickness of Photo Generation Layer

Chun-Wei Lin, Yasushi Hoshino and Shigeru Kitakubo
Nippon Institute Technology
4-1 Gakuendai, Miyashiro, Saitama, Japan

Abstract

Corona charging characteristics of photoreceptor is influenced by pre-exposure. The information of traps is obtained from the change of the charging characteristics by pre-exposure. In this report, the information of traps is analyzed by measuring on OPC (organic photo conductor) with three different thickness of photo generation layer. It is also reported the computer calculation method of the absorption current in OPC from the values of sampled surface voltage.

Introduction

In photosensitive materials, the trapping phenomenon (in photoreceptor, the phenomenon arises as memory effect) generates the change of photoresponse and electric characteristics. The analysis of trapping phenomenon is carried out by the method of measuring charging characteristic of photoreceptor. This method was reported in our previous papers.[1,2] Comparing the corona's charging characteristic of photoreceptor with and without pre-exposure, the difference between two charging curves was obtained. The delay in charging curve is related to the liberation of light activated carriers generated by pre-exposure from the traps in photosensitive layer. To calculate these measuring results, the absorption current by the detrapping was obtained, and the trapping phenomenon was analyzed. In this report, the information of traps is analyzed by this measuring method for three OPC samples with different thickness of photo generation layer. And the computer calculation process of the absorption current from traps in the values of sampled surface voltage of OPC was reported.

Experimentation

1. Measurement of Charging Characteristics for Photoreceptor Drum

To measure the charging characteristics of photo-receptor, photoreceptor analysis system CYNTHIA 59 (by GENTEC Co.)[1] was used. Its block diagram is shown in Fig. 1.

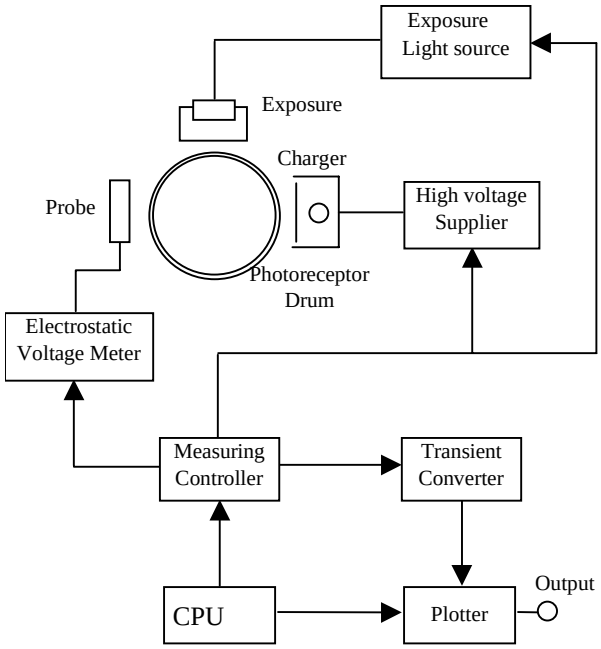


Figure 1. Block diagram of measuring system.

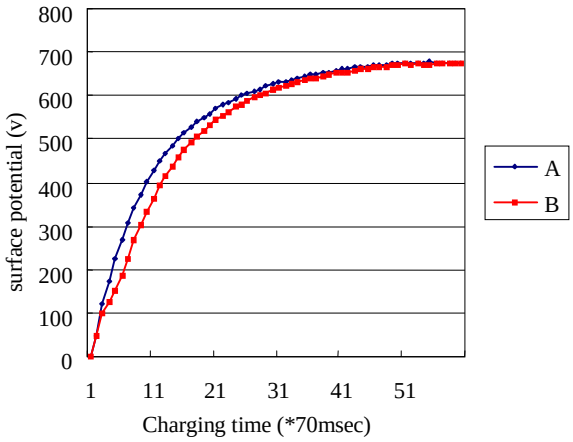


Figure 2. Measured charging surface potential versus charging time.

The measured results on an OPC photoreceptor drum sample is shown in Fig. 2.

In this figure, the curve A of charging surface potential for drum sample is without pre-exposure, and the curve B is with pre-exposure before charging. As mentioned above, the activated carriers by the pre-exposure are captured into traps of photo generation layer, then the trapped carriers are libertated from the traps by applying electrostatic field and neutralize a part of surface charges on photoreceptor drum. So the charging surface potential is shown delayed in the charging curve.

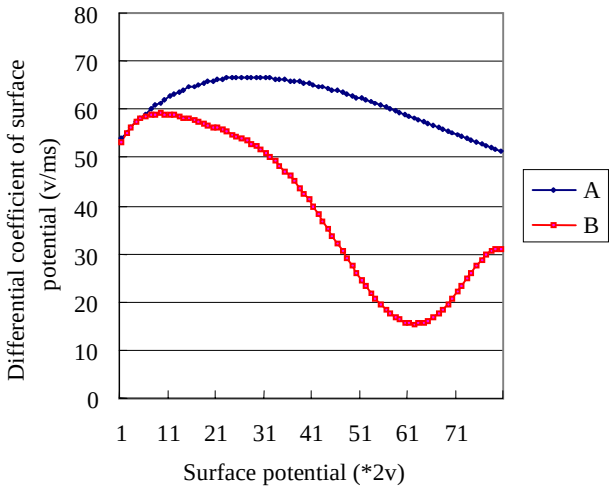


Figure 3. Differential coefficient of surface potential versus surface potential.

2. Calculation for Absorption Current

As mentioned in our paper[3], the calculation of absorption current can use following equations,

$$\text{(when without pre-exposure) } C(dV_s/dt)=j_c-j_i \quad (1)$$

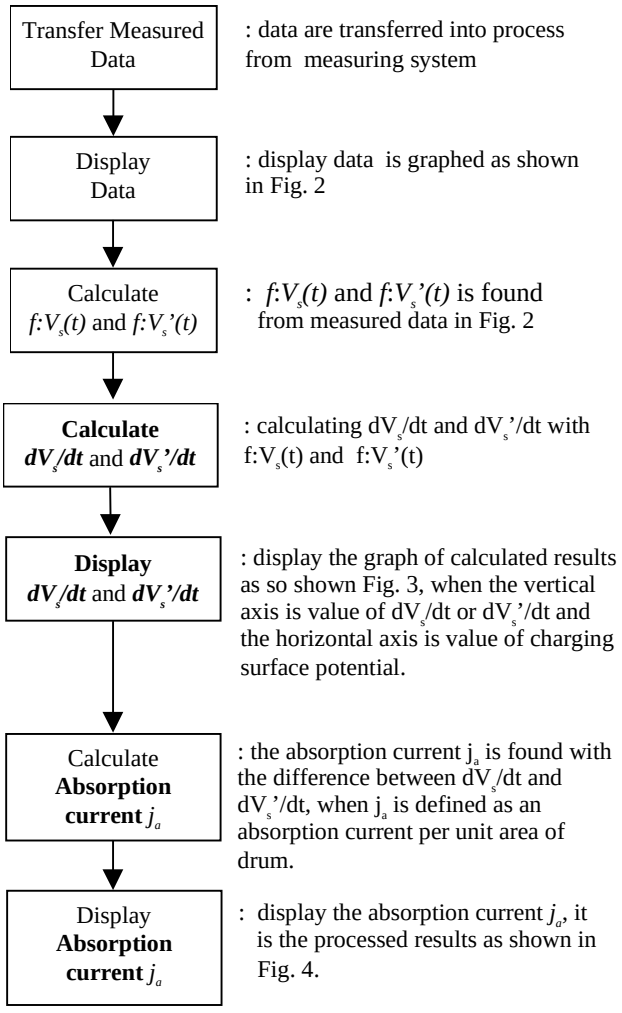
$$\text{(when with pre-exposure) } C(dV_s'/dt)=j_c-j_i' \quad (2)$$

$$C(dV_s'/dt - dV_s/dt) = j_i'-j_i \quad (3)$$

where, C is the capacitance of photoreceptor, j_c is a charging corona current, j_i is an absorption current without pre-exposure and j_i' is an absorption current with pre-exposure respectively.

As shown in Eq.3, the absorption current from traps j_a equals to $j_i'-j_i$, which is calculated as the difference between Eq.1 and Eq.2.

The calculation process is based on these equations, which is examined and shown in the following:



Then with the absorption current as shown in Fig. 4, the information of traps in photosensitive material can be analyzed.

Results and Discussion

We used three photoreceptor drum samples. They are all multi-layer type organic photoreceptors, and their thickness of photo generation layer (CGL) are different; Sample1 = 1um, Sample2 = 2um, Sample3 = 5um, respectively. The measured results of corona charging characteristics are shown in Fig. 5. The curve A represents the charging characteristics of all three drums for the case without pre-exposure. The charging curve B,C,D are with pre-exposure for Sample1,2,3 respectively. And the absorption currents obtained by using the calculation process for Sample 1,2,3 are shown in Fig. 6.

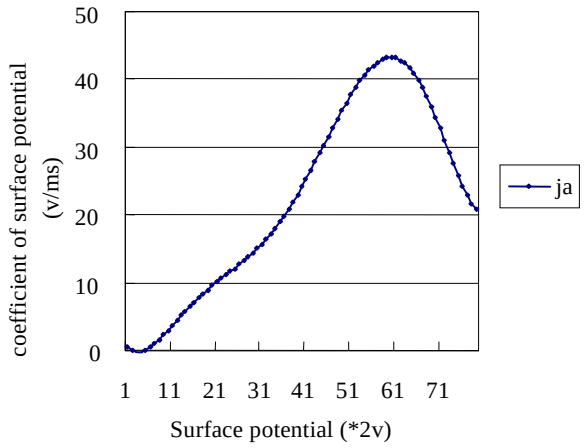


Figure 4. Difference differential coefficient of surface potential versus surface potential.

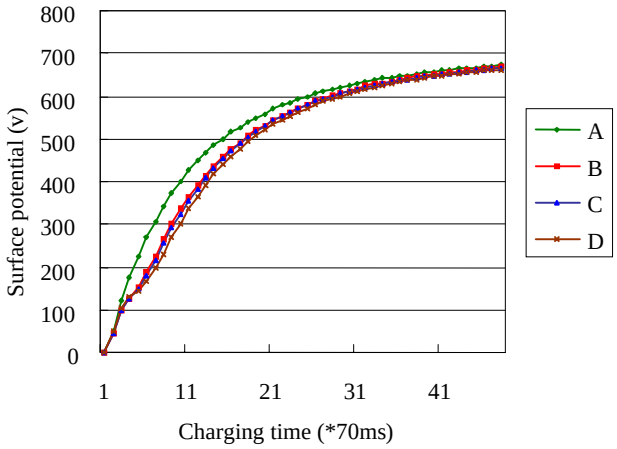


Figure 5. Measured results for drum Sample 1,2,3.

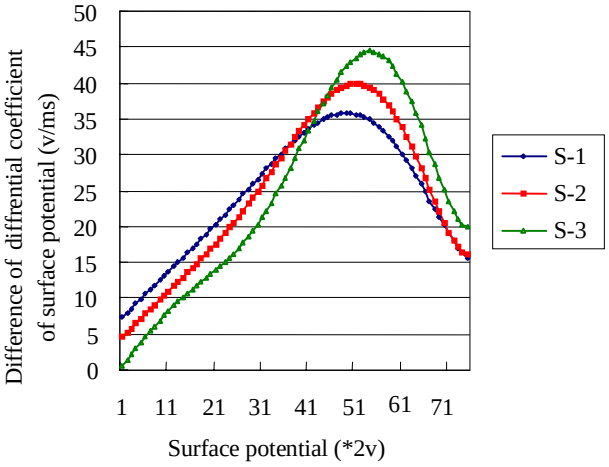


Figure 6. Absorption current for drum Sample1,2,3.

As shown in Fig.5, and 6, because of the pre-exposure before charging, the absorption current peak came out when the surface potential became about 100v during the charging time. Three peaks become bigger as the thickness of CGL increases. The trapped charge amount whih is the integral of absorption current also increases as the thickness of CGL increases. The charge amount seems not to be linear with the thickness of CGL, so it is considered that charge is trapped in CGL and also other parts. The possibility of other parts are the interfaces of CGL and/or CTL.

Conclusion

The trap analysis method proposed by us is improved. This method is based on extracting the difference of the corona charging characteristics between with and without the pre-exposure and is useful to obtain the information of traps in photosensitive materials. Using this method, it was confirmed that the trapping phenomenon depended on the thickness of photo generation layer of layered OPC. Further, since this method makes use of photorecepter analysis system, non-destructive measuring can be accomplished easily. It is expected this is a useful analysis method for photoreceptor evaluation.

Acknowledgements

The authors would like to express their sincere thanks to Mr. T. Murata and Mr. H. Watanabe of Yamanashi Electronics Co. for preparing OPC samples.

References

1. C-W Lin, T. Nozaki and Y. Hoshino, Analysis of traps in photosensitive materials from the dependence of corona charging characteristics on exposure, *IS&T's 13 th international congress on advances in non-impact printing technologies*, p. 270 (1997)
2. C-W Lin, T. Nozaki and Y. Hoshino, Dependence of photoreceptor charging characteristics on pre-exposure conditions, *IS&T's 14 th international congress on advances in non-impact printing technologies*, p. 548 (1998)
3. Y. Hoshino, C-W Lin and T. Nozaki, Measurement of traps by pre-exposure effect on charging characteristics in organic photoreceptor, *Journal of Imaging Society of Japan*, 126, p. 542 (1998)