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A shift register memory of molecular photodiode, consisting of flavin/viologen/TCNQ molecular hetero-LB film, at the molecular level is described. In the shift register memory device, the free electrons of sensitizer molecules have an excited or ground ("1" or "0") state and the electrons are shifted between the functional molecules with photoinduced electron transfer reactions. Based on the transient photocurrent measurement, the shift register memory functions of molecular photodiode were observed with nanosecond time resolution.

Keywords: Shift register memory; Molecular photodiode; Transient photocurrent

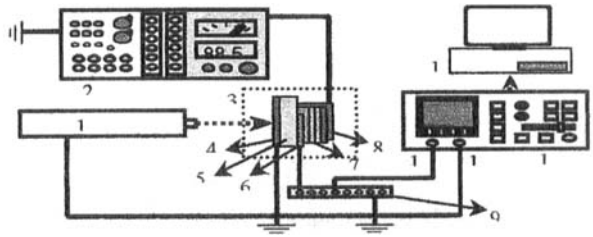
INTRODUCTION

Bioelectronics and molecular electronics have emerged as a breakthrough with great potential capable of generating new concepts and technologies for the development of electronic devices and system[1]. The concept or idea for the development of new functional devices can be inspired from the biological

system such as an electron transfer chain or photosynthetic reaction center[2]. By mimicking the organization of the functional molecules in the biological system, molecular electronic device can be realized artificially[3]. In the molecular photodiode, two kinds of applications to the molecular devices are possible. One of them is shift register memory[4] and the other is fractal memory. In this study, the molecular photodiode consisting of an electron donor. Sensitizer, relay, and acceptor was investigated and the shift register memory function was verified.

EXPERIMENTAL DETAILS

Four kinds of functional materials were used. Ferrocene octadecyl amine (Ferrocene), 7,8-dimethyl-10-dodecyl isoalloxazine (flavin), N-Allyl-N'-[3 -propylamido-N",N"-di(n-octadecyl)]-4,4'-bipyridium dibromide(viologen), and N-docosilquinolinium tetracyanodimethan (TCNQ) were used as a D, S, R, and an A unit, respectively. The deposition of LB films was carried out using a circular type Langmuir trough (Type 2022, Nima Tech., UK). Indium tin oxide (ITO)-coated glass was used as a substrate (bottom electrode). 11 layers of A, and 10 layers of R, S, D were sequentially deposited onto the substrate. The top electrode was a vacuum evaporated aluminum, and thus the molecular photodiode was constructed.



1. Nd:Yag Laser (355 nm, 6 ns FWHM) 2. Boxcar 3. Shield Box 4. Cu 5. Glass 6. ITO 7. film (A/S) 8. Al 9. Amplifier 10. Signal 11. Trigger 12. Oscilloscope 13. Data Acquisition

FIGURE 1. Experimental setup for the transient photocurrent measurement

Fig. 1 shows the experimental setup for the transient photocurrent measurement.

RESULTS AND DISCUSSION

The principle of shift register memory was shown in Fig. 2. In the case of the series (2 or 3 repeated layer of D/S/R/A hetero LB film) of molecular photodiode, when lights are irradiated in the specific region of electron sensitizer, excited electrons can be moved through the redox potential difference.

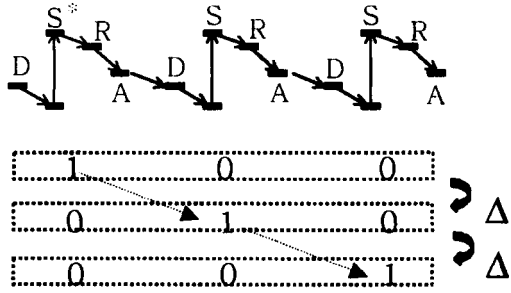


FIGURE 2. Principles of shift register memory

Thus, the excited regions can be shifted as time goes on. If we specify '1' of excited sensitizer and '0' of ground state sensitizer, the '1' cite can be shifted as shown in Fig. 2. The effect of shift register memory can be observed using transient photocurrent data. Fig. 3 shows the effect of shift register memory in the 1, 2 and 3 series of D/S/R/A layer molecular photodiode. In the 1, 2 and 3 repeated unit of D/S/R/A molecular photodiode, the different decay rates of photocurrent were observed. It is thought that if the charge transfer mechanism were constituted, analysis of the shift register memory effect would be possible.

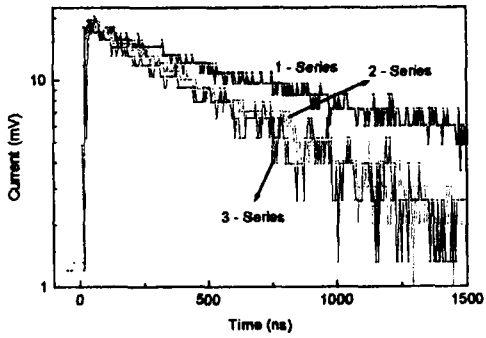


FIGURE 3. Shift register memory effect of molecular photodiode

CONCLUSION

The shift register memory effect was clearly observed due to the transient photocurrent measurement. In this result, we can conclude that the D/S/R/A structured molecular photodiode will be used as a memory device.

Acknowledgements

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References

[1.] J.W. Choi, G.Y. Jung, S.Y. Oh, W.H. Lee and D.M. Shin, *Thin Solid Films*, **284/285**, 876(1996).
[2.] J.W Choi, M.J. Kim, S.W. Chung, S.Y. Oh and W.H. Lee, *Molecular Crystal & Liquid Crystal*, **294**, 217 (1997).
[3.] K. Akiyama, S. Nishikawa, S. Ueyama and S. Isoda, *Jpn. J. Appl. Phys.* **34**, 3942 (1995).
[4.] J.J. Hopfield, J. N. Onuchic and D. N. Beratan, *J. Phys. Chem.* **93**, 6350 (1989)