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Optical Recording Properties of Styryl Derivatives for Digital Versatile Disc-Recordable (DVD-R)

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Abstract New styryl dyes for the recording layer of digital versatile disc-recordable (DVD-R) were synthesized and analyzed by UV-vis spectroscopy and thermal analyzer. Using these dyes, we prepared two-type DVD-R discs, with/without metallic thin film between substrate and organic buffer layer. The metal-polymer deformation 4.7 GB DVD-R discs were recorded by high-power 658nm-wavelength laser diode and their recording characteristics were evaluated at 650nm wavelength. The optimum writing power and jitter value was in the range of 10 mW and 12~13 %, respectively.

Keywords styryl dyes; DVD-R; metal-polymer deformation; optical disc

INTRODUCTION

The compact disk-recordable (CD-R) has been the most popular recordable optical media in the world. The digital versatile disc-recordable (DVD-R) was developed for higher density recording than CD-R using thermal decomposition technology of dyes. Recently, since the standardization of 4.7 GB digital versatile disc recordable (DVD-R) has been completed, therefore, it is expected that the demand of DVD-R will increase remarkably in accordance with the rapid growth of the DVD market such as computers, games and movies.

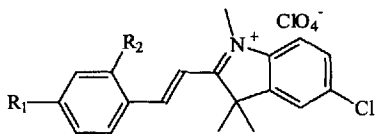
The organic dyes for the recording layer of DVD-R require high molar absorption coefficients, sharp threshold of thermal decomposition, high thermal and photochemical stability, and good solubility in specific solvents, etc [1]. One of the most important requirements of dyes would be that they must have a suitable amount of absorption at a wavelength of a writing laser (635 nm or 658 nm). At this point of view, the styryl-type dye system would be much available because we can easily modify electron-donating or accepting groups inside the structures so that we can shift precisely the UV-vis spectra of organic dyes. In this study, we developed newly several styryl dyes derivatives by means of changing the substituents of dyes. We investigated herein the relationships between chemical structures and UV absorption spectra. On the other hand, we have demonstrated the feasibility of the metal-polymer deformation (MPD) DVD-R, with a metal thin film between substrate and organic dye layer [2-3]. Using these styryl dyes, we fabricated two-type DVD-R discs; a conventional dye-based DVD-R and a MPD DVD-R. These discs were recorded by high-power 658 nm-wavelength laser diode and their recording characteristics were evaluated at 650 nm wavelength laser diode.

EXPERIMENT

The dyes in this study were synthesized by a condensation of the corresponding aldehydes with 5-chloro-1,2,3,3-tetramethyl-3H-indolium perchlorate. The MPD DVD-R was fabricated as follows. The Ta thin film of 10 nm was applied by DC sputtering on the PC substrate having pregroove whose track pitch and depth are 0.80 um and 160 nm, respectively. Organic dye solution was spin-coated on the Ta sputtered substrate with 70 nm of thickness on the groove. The silver reflective layer of 100 nm and protective layer were applied successively, and dummy disc was bonded. The DVD-R disc with conventional structure that has same organic dye layer without Ta thin film was also prepared in order to compare with MPD DVD-R. Recording characteristics of these discs were evaluated by Pulstec DDU-1000 evaluation system with 658 nm LD, and with 650 nm LD (NA = 0.6) at 3.84 m/sec.

RESULTS AND DISCUSSION

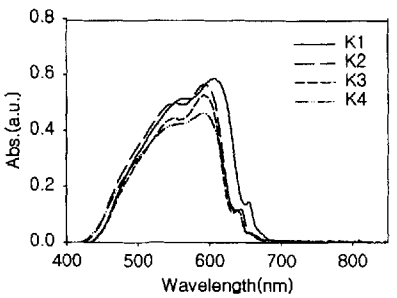
The structures of organic dyes are shown in the FIGURE 1. The substituents, R_2 are CH_3, OCH_3, OC_4H_9, which are expected to be related to UV-vis absorption characteristics.



K1 (R_1= $N(CH_2CH_3)_2$, R_2=CH_3)
K2 (R_1= $N(CH_2CH_3)_2$, R_2=OCH_3)
K3 (R_1= $N(CH_2CH_3)_2$, R_2=OC_4H_9)
K4 (R_1= $N(CH_2CH_3)(CH_2CH_2Cl)$, R_2=CH_3)

FIGURE 1. The structures of styryl dyes in this study

The FIGURE 2 and 3 show their absorption spectra on the polycarbonate substrate and their thermogravimetric diagrams of dyes, respectively. Among these dyes, the K1 dye had the highest λ_{max} of 613 nm as well as the sharpest threshold of thermal decomposition, which can be a good candidate for 658 nm recordable organic dye. The other derivatives (K2~K4) had too low λ_{max} to be used for 658 nm recording.



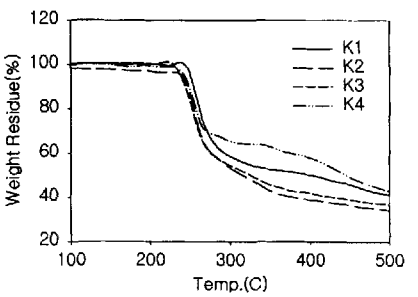


FIGURE 2. Absorption spectra of dyes FIGURE 3.TG diagrams of dyes

TABLE I summarized the recording characteristics of the MPD disc and the disc without metal thin film. The reflectivity (R_{top}) and optimum writing power (OWP) were about 58~60 % and about 10 mW, respectively. The eye pattern recorded by 8/16 multipulse is shown in FIGURE 4. The dye K1

shows the best jitter of 11.6 and 13.3 % at conventional dye-based and MPD DVD-R, respectively. Despite of lower λmax of K4, dye-based DVD-R using K4 exhibited almost same recording properties compared to K1. The MPD DVD-R of K1 shows a little higher jitter than general dye-based DVD-R, but shows a higher modulated amplitude (I_{14}/I_{14H}). The K1 was not fully satisfactory in terms of all DVD-R specification because the required specification of jitter is below 8~9%, however, it is expected that the styryl-based dye can be a newly good candidate for DVD-R dyes through a slight modification of the molecular structure.

TABLE 1. The basic recording properties of 4.7 GB DVD-R

dye	DVD-R system	Rtop(%)	OWP(mW)	Jitter(%)	I_{14}/I_{14H}
K1	Dye-based	59.6	9.8	11.6	0.41
	MPD-based	58.0	10.2	13.3	0.54
K4	Dye-based	58.5	10.4	12.1	0.53

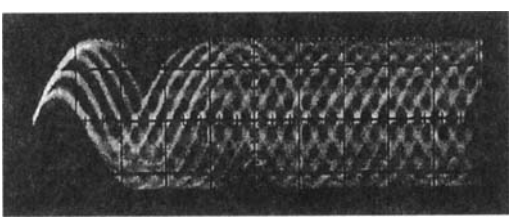


FIGURE 4. Eye-pattern of MPD DVD-R recorded by 8/16 multipulse with equalizer gain of 3.2 dB.

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