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Hemicyanine Dye for Optical Recording

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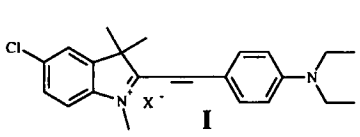
A hemicyanine dye was synthesized and investigated to apply for digital versatile disc recordable (DVD-R). The optimized dye showed excellent recording performance, which satisfies the specification of DVD-R. It was clearly shown that the hemicyanine dye is a promising candidate for optical recording material for DVD-R.

Keywords: hemicyanine; DVD-R; optical recording

INTRODUCTION

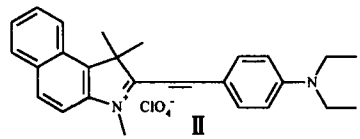
Digital versatile disc recordable (DVD-R) is promising because it can store enormous amounts of digital data and can be fully compatible with DVD-ROM. Its fundamental structure and recording mechanism are similar to those of compact disc recordable (CD-R). However, its recording wavelength, mark length and track pitch are different from those of CD-R[1]. This change of laser wavelength needs new recording materials.

In this paper, we synthesized compound **I**-**III** and studied the effects of their structure on the thermal and optical properties. Based on the results, a new recording material for 635nm recording was selected and used to fabricate DVD-R. The results of these studies are reported here.

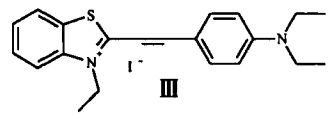


I

X = Cl (**Ia**), BF_4 (**Ib**), ClO_4 (**Ic**)



II



III

EXPERIMENTAL

Hemicyanine dyes were prepared by the conventional procedure[2]. DVD-R discs were prepared using the fabrication procedure of Metal Polymer Deformation (MPD) disc[3]. Recording characteristics were measured with a spindle-tester equipped with 635nm LD (Pulstec, DDU-1000).

RESULTS AND DISCUSSION

According to the previous reports[1, 4], we set following guidelines for developing the recording material. The recording layer absorbs the focused light, generates heat and induces changes in the optical properties of the materials. Therefore, a dye as the recording layer has to absorb the focused light for the generation of heat, but low absorption is necessary to obtain a high reflectivity[4]. The changes in the optical properties induced by the heat are strongly dependent on its thermal properties. In general, the sharp threshold of thermal decomposition makes the mark edge clear and improves mark jitter[1]. In addition to these guidelines, a dye having a high refractive index is preferred to obtain a high modulation[4].

As a candidate material, we selected hemicyanine dyes having a strong absorption band at 500nm-600nm because a high refractive index can be obtained with a strong absorption band. Hemicyanine dye **I-III** were synthesized and spin-coated on a polycarbonate substrate. Their spectra were measured with UV-VIS-NIR spectrophotometer

(SHIMADZU, UV-3101PC). They were shown in Figure 1. **Ia** and **II** have two absorption bands at around 600nm and 550nm. In contrast, **III** has a absorption band at around 500nm. According to Kramers-Kronig relations[4], the strong absorption at around 600nm observed for **Ia** and **II** is more influential for high refractive index at 635nm than that of 500nm. The week absorption shoulder near 600nm observed for **III** reveals the low refractive index of **III**. Therefore, we could exclude **III** from the consideration.

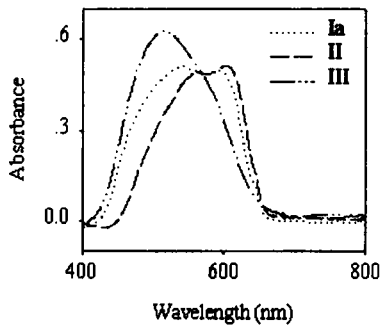


FIGURE 1. Absorption spectra of **Ia-III**.

Next, to select a dye having a high reflectivity, reflectivity of discs prepared from **Ia** and **II** were measured. They showed 50-60% and 30-45%, respectively. The low reflectivity of **II** can be attributed to high absorption at writing wavelength. We can also exclude **II** from the candidate materials.

Ia was selected as a recording material and used to fabricate discs. Even though **Ia** has desirable optical properties, the fabricated discs showed poor mark shapes and low sensitivity. As mentioned before, this result can be attributed to the poor thermal properties of **Ia**. In order to change the thermal properties of **Ia**, **Ib** and **Ic** having tertafluoroborate and perchlorate as an anion were synthesized, respectively. Differential thermal analysis (DTA) was carried out at a heating rate of $10^{o}Cmin^{-1}$ in an N_2 atmosphere. They were shown in Figure 2. In contrast to an endothermic behavior observed for **Ia**, the thermal decomposition of **Ib** and **Ic** showed an exothermic behavior. **Ic** showed a sharper exothermic peak than **Ib**. Considering that the sharp threshold of thermal decomposition makes the mark edge clear and reduces mark jitter, **Ic**

was expected to have better recording properties than **Ia** and **Ib**.

As predicted by thermal analysis, in contrast to the poor mark shapes observed in **Ia** and **Ib**, the discs prepared from **Ic** showed the formation of good mark shapes. When multi-pulse 8/16 modulated random data with 0.44 μm of the minimum mark length were recorded at 3.8m/sec, the signal pattern of an optimized disc was shown in Figure 3. It showed excellent recording performance, which satisfies the specification of DVD-R.

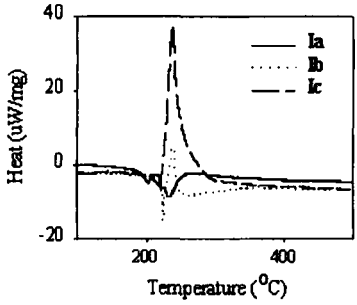


FIGURE 2. DTA thermo-gram of **Ia, Ib and Ic**.

Following the guidelines for an optical recording material, we can develop a new recording material for DVD-R. Considering the excellent recording properties of **Ic**, it can be concluded that hemicyanine dye is a promising candidate for optical recording material for DVD-R.

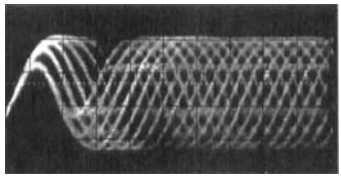


FIGURE 3. Optical signal of multi-pulse 8/16 modulated random data.

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