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OPTICAL RECORDING STUDY OF CYANINE DYE-TCNQ COMPLEXES

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Abstract Four cyanine dye-TCNQ (Tetracyanoquinodimethane) complexes were synthesized and used as optical recording media. The optical recording properties of cyanine dye-TCNQ complexes were compared with cyanine dyes. Cyanine dye-TCNQ complexes are spin coatable and highly sensitive to laser light. High CNR (carrier to noise ratio) could be obtained even with low laser power and high recording speed. The preparation of cyanine dye-TCNQ complexes and their spectral properties along with the optical recording measurements were discussed.

INTRODUCTION

Recently, considerable attention was directed toward the optical recording as a method of high density recording and various optical recording media have been studied and developed. Among them, R. S. Potember et al.[1,2] had found that metal-TCNQ charge trasnsfer complex has optical memory effect nothin but optical switching effect. They have prepared Cu-TCNQ and Ag-TCNQ by vacuum deposition or sputtering on glass substrate and observed optical memory effect.

$$[M^{+}(TCNQ^{\cdot})]_n \underset{\triangle}{\overset{E \text{ or } h\nu}{\rightleftharpoons}} M_x + [M^{+}(TCNQ^{\cdot})]_{n-x} + TCNQ_x$$

However, metal-TCNQ complexes except Li-TCNQ are insoluble in organic solvent, so

high cost process like vacuum deposition or sputtering is necessary to prepare the recording media. Thus, we have studied the soluble organic charge transfer complex and synthesized dye-TCNQ complexes which have cyanine dye as electron donor.

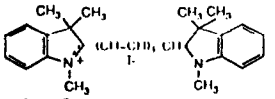
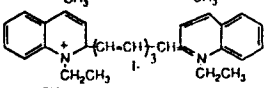
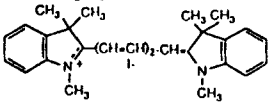
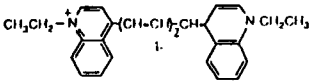
They are soluble in usal organic solvents and spin coatable. This paper deals with the preparation of recording media and their optical memory effect. The physical and spectroscopic properties of the cyanine dye-TCNQ are reported also.

EXPERIMENTAL

SYNTHESIS OF THE CYANINE DYE-TCNQ

Cyanine dyes were obtained from Nippon Kankoh Shikiso Kenkyusho Co., Ltd and they are listed in Table I .

TABLE I Structure and light absorption data of cyanine dyes.

	Structure	λ_{max} in MeOH
DYE I		741 nm
DYE II		817 nm
DYE III		814 nm
DYE IV		638 nm

The cyanine dye and Li-TCNQ were mixed in acetonitrile: EtOH(1:1) cosolvent under nitrogen atmosphere. Li-TCNQ was prepared by Merby's method[8].

IDENTIFICATION

The synthesized complexes were confirmed by their IR and UV-VIS spectra and their thermal properties were measured with STA.

PREPARATION OF RECORDING MEDIA AND OPTICAL RECORDING STUDY

The cyanine dye-TCNQ were dissolved in 2,2,3,3-tetrafluoro-1-propanol, 2,2,2-trichloro-ethane or 2,2,2-trifluoroethane (0.01g/mℓ) and spin coated on Al deposited PC substrate. Layer thickness were adjusted by changing spin coating speed at 500~2500rpm. After drying, the samples are tested by using Optical Disk Driver DDU-1000 manufactured by Pulstec.,Inc. A laser diode of 830nm was used as the recording and reading source. The recording speed, power and signal frequency was varied and the reading power was fixed to 0.8mW. The recored data were analyzed by spectrum analyzer and CNR were measured. The erasing study was performed by bulk erasing using convection oven. Figure 1 shows the recording media structure.

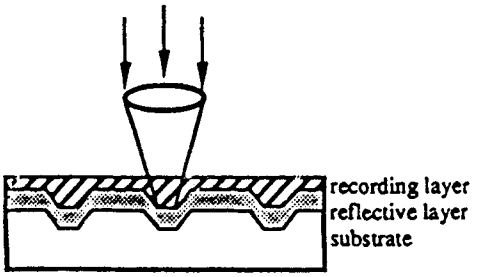


FIGURE 1 Recording media sturcture.

RESULTS AND DISCUSSION

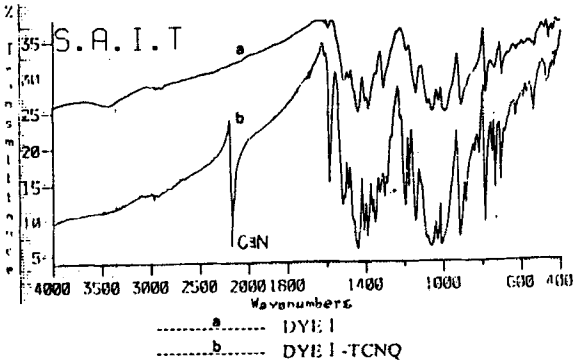


FIGURE 2 IR spectra of DYE I and its TCNQ complex.

IDENTIFICATION OF COMPLEXES

Figure 2 shows the IR spectra of DYE I and its TCNQ complex. Figure 3 shows the UV-VIS spectra of DYE I ,IV and their TCNQ complexes. Both complexes show C N absorption band at 2230cm^{-1} in IR and λ_{abs} at 421, 841nm in UV-VIS spectra, which are the characteristics of TCNQ complex[4]. Especially, DYE IV has not any absorption at 780~840nm, but its TCNQ complex show absorption at this region. In the STA thermogram, Figure 4, the TCNQ complex of DYE I is thermally more stable than dye only.

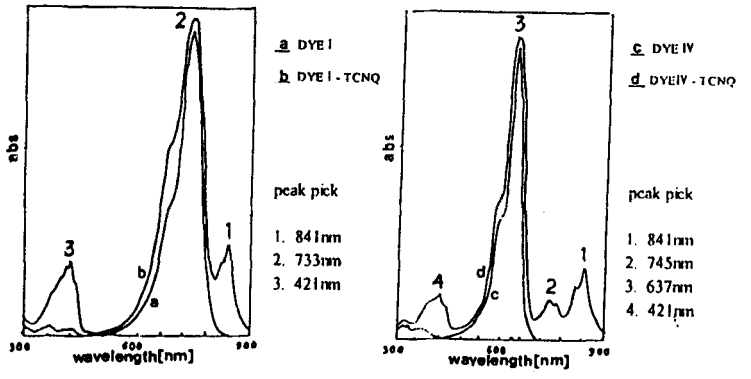


FIGURE 3 UV-VIS spectra of DYE I ,IV and thier TCNQ complexes.

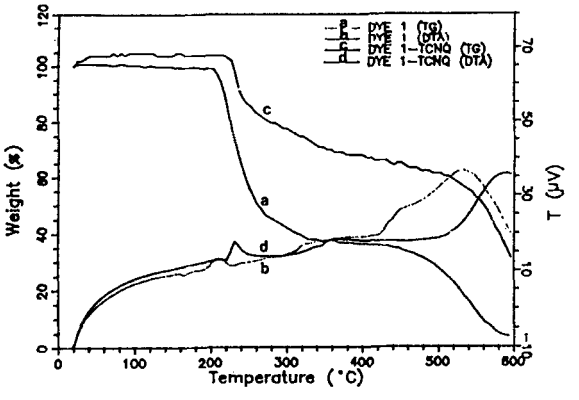


FIGURE 4 STA thermogram of DYE I and DYE I -TCNQ.

RECORDING AND ERASING CHARACTERISTICS

The reflectance of the samples ranges about 30~70% by changing the spin coating speed and the laser focusing and tracking were possible with 0.8mW reading power. Figure 5,6,7 and 8

show the measured CNR at DYE-TCNQ compared with dye.

High CNR can be observed even with high recording speed and low recording power. It shows that the media composed of cyanine dye-TCNQ complexes has high recording sensitivity. Especially, DYE IV was not recored at 830nm(no absorption), but its TCNQ complex was recored at 830nm with high CNR. It indicates that it is possible to shift λ_{abs} range of cyanine dye to semiconductor laser diode region(780~830nm) by synthesizing its TCNQ complex. Figure 9 show the residual CNR according to erasing condition. Perfect erasing and rewriting was not possible. The above results show that cyanine dye-TCNQ complexes have optical memory effect as the WORM(write once read many) media with high CNR.

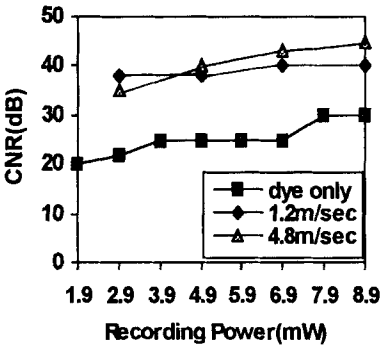


FIGURE 5 CNR data of DYE I and its TCNQ complex.

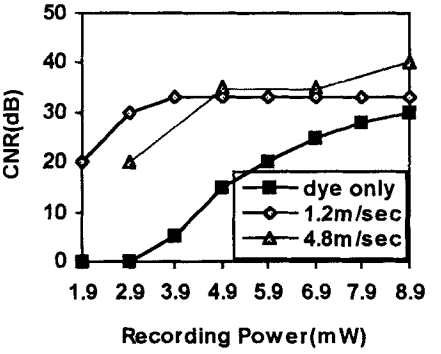


FIGURE 6 CNR data of DYE II and its TCNQ complex.

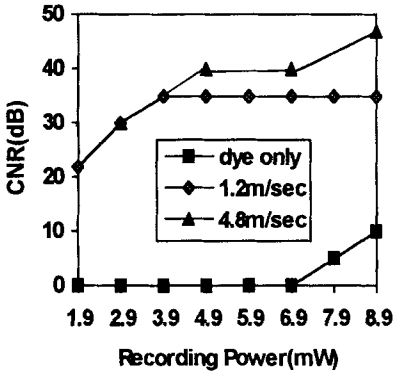


FIGURE 7 CNR data of DYE III and its TCNQ complex.

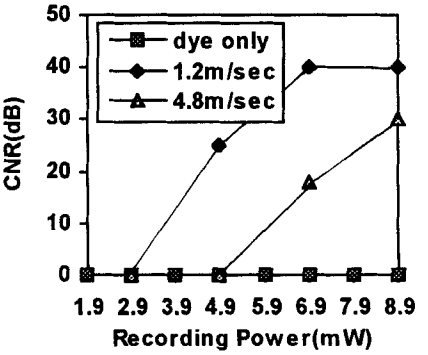


FIGURE 8 CNR data of DYE IV and its TCNQ complex.

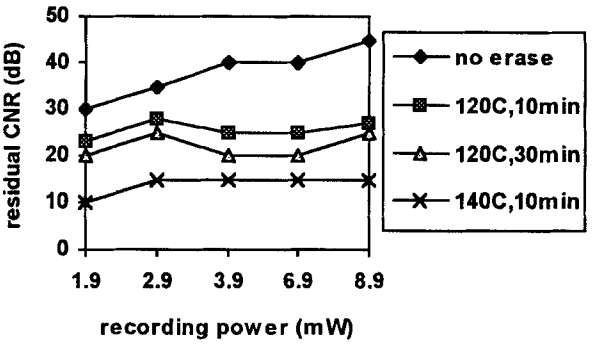


FIGURE 9 The residual CNR of DYE Ⅰ-TCNQ according to bulk erasing condition.

CONCLUSIONS

Four cyanine dye-TCNQ complexes were synthesized and characterized by UV-VIS and IR spectra. They are soluble in organic solvent and spin coatable. The complexes show high CNR even with low recording power and high recording speed. Also, it is possible to shift λ_{abs} range of cyanine dye to near IR reagion (780~830nm) by synthesizing dye-TCNQ complex.

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