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Hole Mobility of Fluorene-Based Dyes

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Four fluorene-based dyes were newly prepared and they were demonstrated to possess excellent hole-transporting capability from the conventional time-of-flight measurement. In particular, a fluorene-based dye with diphenylamino groups exhibited high mobility of 1.8×10^{-3} $cm^2V^{-1}s^{-1}$, which is about twice that of typical hole conductor N,N'-diphenyl-N,N'-(m-tolyl)-benzidine (TPD), in vacuum-deposited film

Keywords: hole mobility; fluorene dyes; time-of-flight

INTRODUCTION

Development of carrier-transporting materials with high mobility is indispensable to attain high performance organic light emitting diode (LED) and organic solar cell. For example, high carrier mobility is expected to provide lowering of drive voltage in organic LED[1] and lowering of cell resistance which leads to high conversion efficiency in organic solar cell.[2]

Recently, poly(dialkylfluorene)s and related polymers were demonstrated to exhibit high hole mobility in amorphous and liquid crystalline films.[3-5] The results suggest that the fluorene-skeleton is a promising base-structure in the molecular design of hole conductor. In

this work, we prepared fluorene-based dyes and evaluated their hole mobility.

EXPERIMENTAL

Figure 1 shows chemical structures of four fluorene-based dyes, FPD, 2C6DAF, 2C6CbzF and 2C6NF, newly prepared in this work. In their hole mobility measurement, sandwich-type samples were employed. Fluorene-based dye films (thickness = several μm) were vacuum-deposited on ITO-coated glass substrates, and semitransparent Al was deposited as top electrode. Hole mobility was evaluated with the time-of-flight (TOF) measurement using third harmonic of Nd:YAG laser (wavelength = 355 nm, pulse width = 3 nsec) as excitation source.

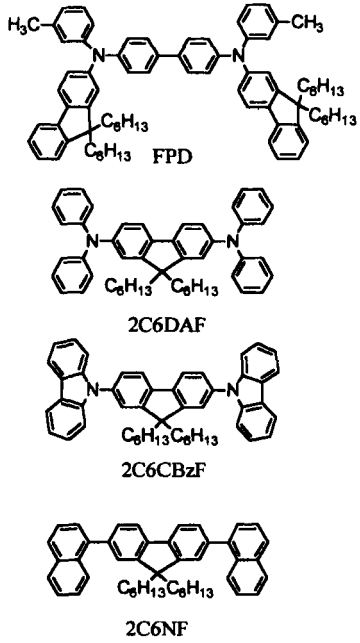

FIGURE 1 Chemical structures of fluorene-based dyes employed in this study.

RESULT AND DISCUSSIONS

In the TOF measurement, FDP and 2C6DAF exhibited non-dispersive type photocurrent signal due to hole-transport (Fig.2.); an apparent plateau part followed by decreasing tail was observed in the photocurrent transient profiles and transit time t_T was successfully determined from the inflection point from plateau to tail. In 2C6CBz, on the other hand, photocurrent signal due to hole transport is dispersive. Then, transit time was determined from the inflection point

in double-logarithmic plot of the photocurrent transient. Drift mobility μ was calculated according to the equation $\mu=L/t_TF$, where L is film thickness and F applied field.

In 2C6NF, the photocurrent transient was too dispersive to determine transit time. Accordingly, we could not evaluate the mobility of 2C6NF.

Figure 3. shows the field dependencies of hole mobility of the fluorene-based dyes. The fluorene dyes exhibit relatively high hole mobility; hole mobility of FPD and 2C6DAF is at the level of $10^{-3}cm^2V^{-1}s^{-1}$ and that of 2C6CBz at the level of 10^{-4} $cm^2V^{-1}s^{-1}$. In particular, mobility of 2C6DAF is1.8 x 10^{-3} $cm^2V^{-1}s^{-1}$ at $3.3x10^5Vcm^{-1}$; this value is about twice that of typical organic hole conductor, TPD. The results demonstrate that

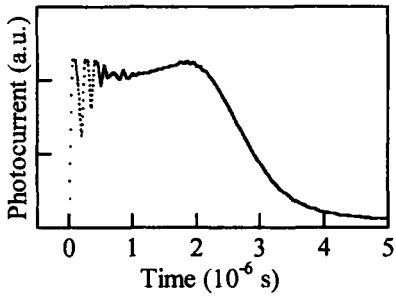

FIGURE2 Transient photocurrent signal due to hole transport for 2C6DAF vacuum-deposited film.

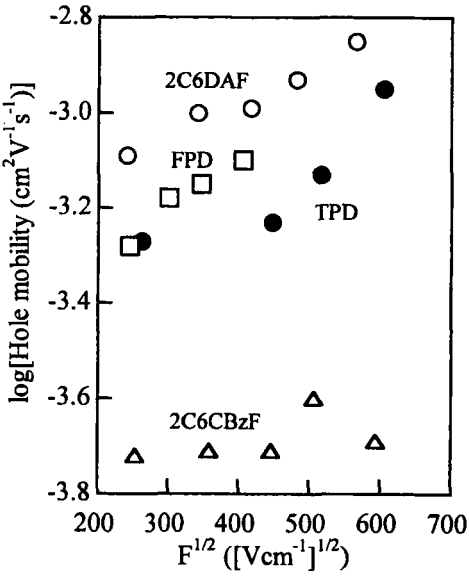

FIGURE 3 The electric field dependencies of hole mobility of fluorine-based dyes

fluorene-based dyes are promising as hole conductor.

CONCLUSION

Fluorene-based dyes newly prepared in this study were demonstrated to possess high hole mobility at the level of 10^{-3} $cm^2V^{-1}s^{-1}$. This result reveals excellent hole-transport capability of the fluorine-based dyes.

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