HOLE TRANSPORT IN OXADIAZOLE DERIVATIVE

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Abstract

Electron drift mobilities have been measured in one of oxadiazole derivative as the function of the electric field. All exposures were 3 ns in duration and derived from the dye laser (λ = 724 nm) spectral response of this film is about 400-900 nm. Our research show that the mobility in disordered materials, such as oxadiazole derivative, is exponentially dependent on the square root of the electric field. Then oxadiazole derivative films can be used for electrophotography and xerography application.

1. Introduction

Molecularly doped polymers are widely used as photoreceptors for electrophotography. As a consequence, charge transport in these materials has been extensively investigated during in last time[1-7]. These materials are normally prepared as binary solid solutions containing a strong electron donor or acceptor in a host polymer. Hole or electron transport involves the exchange of an electron from sites associated with adjacent donor or acceptor molecules, respectively. Based on the magnitude of the mobilities and the dependence of the mobilities on the concentration of the dopant molecules, it has generally been accepted that the transport occurs by hopping process. The mobilities are typical 10^{-4} - 10^{-9} cm^2/V· s, far too small to be described by band transport. Thus far, however, there is no microscopic hopping theory that has been shown to satisfactorily describe charge transport in a wide range of molecularly doped polymers.

In this paper the results of an investigation of electron drift mobilities in oxadiazole derivative as function of the electric field are described.

2. Experimental method

Molecularly doped polymers oxadiazole derivative: 2-(4-biphenyl) 1 -5(t-butylphenyl) -1,3,4- oxadiazole (PBD) as a discovered molecular solids have been used. The samples are fabricated from a binary solid solution of charge transporting molecule dispersed in inert polymeric binder. Following, deposition of PBD layer, a semitransparent indium tin oxide (ITO) layers were vapor deposited on the free surface. Titanium oxide phthalocyanines (TiOPc) as the photoemitting layer were used. Aluminum electrodes are the second contact.

Thickness of the doped polymer films were about 20 μm. The drift mobilities (μ) were measured by conventional time-of-flight techniques (Fig. 1) [8,9]. By this method, the displacement of a sheet of carriers injected from a photoemitting electrode is time resolved.

Photoexcitation of the TiOPc emitter layer was accomplished by 3 ns exposures of 724 nm radiation derived from a dye laser (PRA, LN-107). The photocurrent transient was measured with a transient digital system (Board Master 800 AB 1 8). Photoexcited electrons are injected into the sample at t=0 by the pulse of radiation with flash duration that is short compared to the electron transit time, τ. When R is selected such that RC « τ, the current that flows in the sample is proportional to the voltage across R. Here C represents the combined capacitance of the sample and the measuring circuit. When the electrons exit the sample at x = L, the current decreases. The transit time is related to the drift mobility as $\tau = L^2/ (\mu V)$,

where L is thickness of the sample and V is the applied voltage. It is assumed that the electric field within the sample is uniform and given as V/L. For these measurements, R was usually selected as 10^5 Ω. This resulted in a RC-time constant of 10^{-5} s, considerably less than the observed transit time.
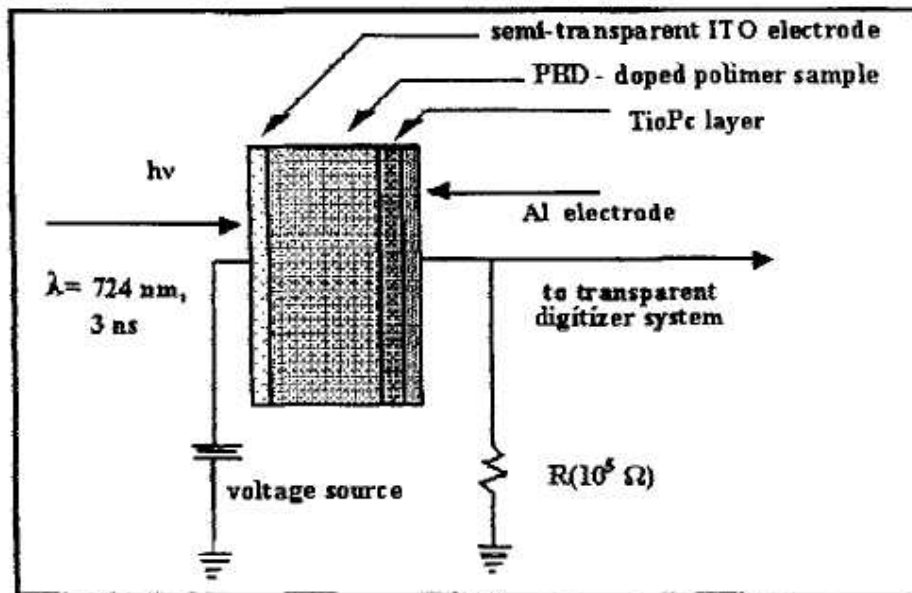

Fig. 1. A schematic diagram of the experimental arrangement.

3. Experimental results and discussion

The spectral response of TiOPc layers is represented in Fig. 2. As we can see, the spectrum surrounds the range of wavelength in the interval 400-900 nm. The decrease is response at shorter wavelength could be due to charge-transport layer absorption. The maximum of photosensitivity used films corresponds $\lambda_{max.} \sim 724$ nm that determined a choice of dye laser radiation with suitable wavelength.
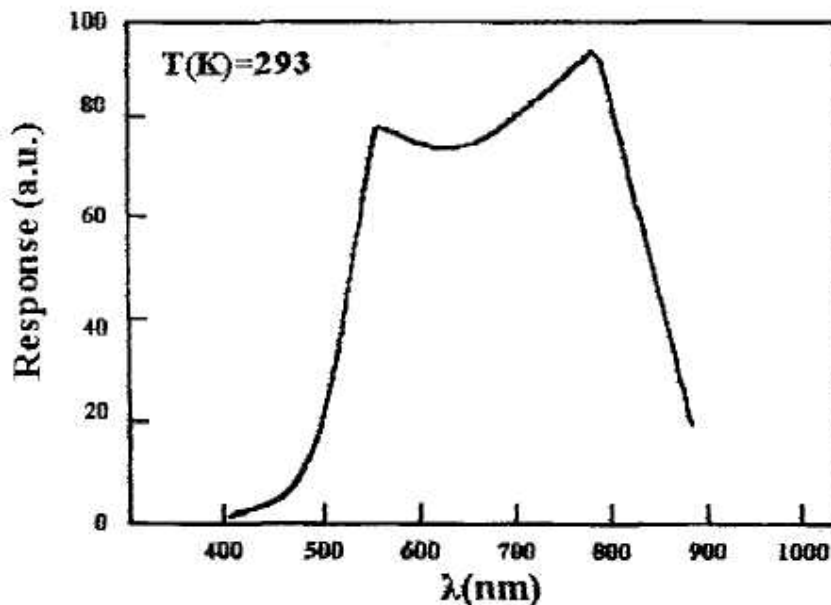

Fig. 2. Spectral response of the TiOPc photoemitting layer.

A typical transient current pulse is shown in Fig. 3. The current is characterized by the

sharp pulse at t = 0, a plateau, and a dispersive tail. The sharp current spike at t=0 is caused by the rapid drift of the photoexcited holes and electrons through the TiOPc layer. The point between the plateau and the dispersive tail is defined as the transit time τ of the initial sheet of carries. The slow drop-off or the tail following the transit time is caused by the dispersion of the carrier packet as it drifts through the organic film.
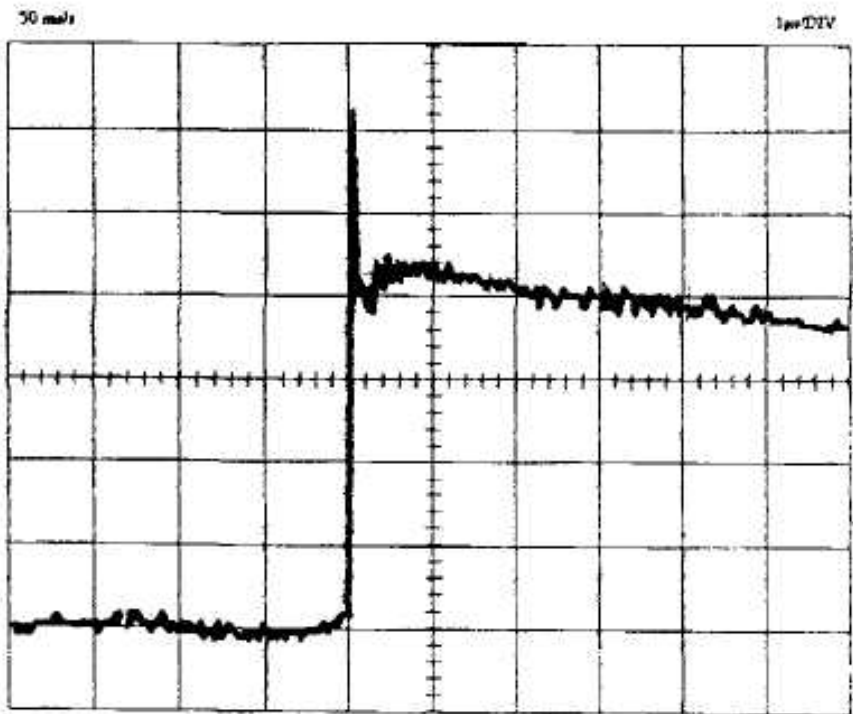

Fig. 3. Photo-current transients measured at 100 V applied voltage.

Fig.4, a illustrate a plot of τ versus applied electric field E. As can see the τ reduces by increasing of the E. For $E_{max.} = 1.15x \ 10^5$ V/cm correlate with t= 5 x 10^{-7}s. These values of the τ are much less than for other disordered materials using for electrophotography application.
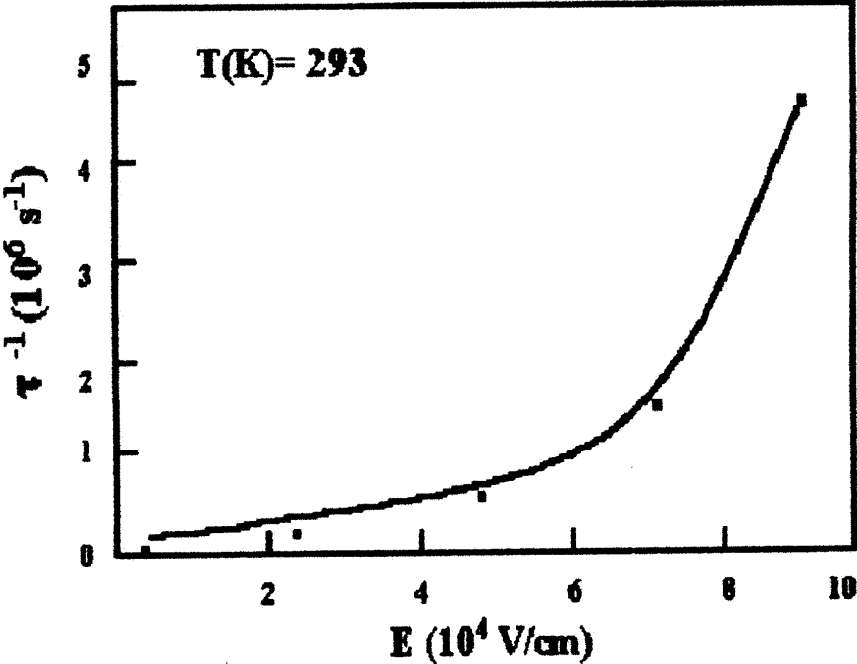

Fig. 4, a. Transit time versus of the applied field.

Fig.4,b illustrate the field dependencies of the mobility measured at room temperature. These results indicates that the field dependence can be best described by an exponential dependence on the square root of the electric field $\mu(E)\sim\exp(\beta \cdot E^{1/2})$, where β is the temperature-dependent constant. The predicted field dependence is very similar to the Poole-Frenkel behavior frequently observed in transport measurements of doped polymers [8, 10]. The specific form of the field dependence is determined by the field dependence of the average energy of the charge carrier after equilibration within the density-of-states distribution and the form of the distribution.
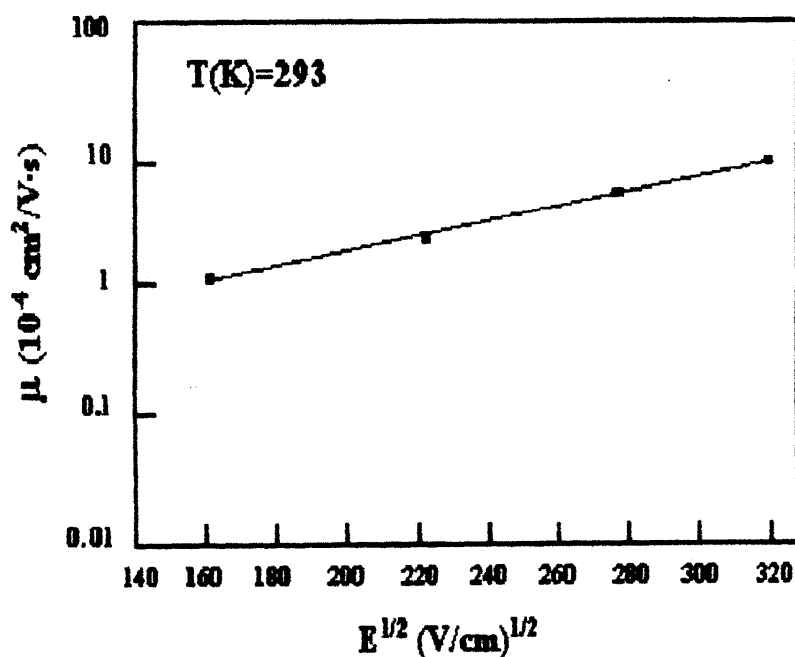

Fig. 4, b. The field dependence of the mobility.

In conclusion we must note, because the transmission spectra of the TiOPc films correspond to visible range of spectrum and the time travels of charge carriers in PBD layers are by order of magnitude less than for other disordered materials, that oxadiazole derivative could be applied in electrography and xerography.

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OKSADIAZOL DERIVATIV KOMPOZIT MATERIALDA HOLL KÖÇÜRMƏ EFFEKTI

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Oksadiazol derivativ kompozit materialın dreyf yürüklüyünün elektrik sahəsindən asılılığı təcrübi olaraq ölşülmüşdür. 400-900nm spektral oblastında həssaslığa malik olan ksadiazol derivativ nazik təbəqələri dalğa uzunluğu λ = 724nm, həyəcanlaşma müddəti 3ns olan maye lazer şüaları vasitəsi ilə işıqlandırılmışdır. Tədqiqatlar göstərir ki, bu maddələrin yürüklüyü elektrik sahəsindən eksponensial asılı olaraq dəyişir. Göstərilmişdir ki, oksadiazol derivativ nazik təbəqələri elektrofotoqrafiyadə geniş tətbiq oluna bilər.

ХОЛЛОВСКИЙ ПЕРЕНОС В ОКСАДИАЗОЛ ДЕРИВАТИВ

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В композиционном материале оксадиазол дериватив экспериментально исследована зависимость дрейфовой подвижности от приложенного электрического поля. Тонкие пленки, спектральная чувствительность которых охватывала диапазон длин волн в интервале 400-900nm, подвергались облучению жидкостного лазера с длиной волны λ = 724nm и длительностью порядка 3нс. Исследования показывают, что подвижность этих пленок экспоненциально зависит от электрического поля. Показано, что тонкие пленки оксадиазол дериватив успешно могут применяться в электрофотографии.