Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/gmcl19

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Sergey Svechnikov [a], Petro Smertenko [a], Nikolay Guba [b], Ludmila Grebinska [b], Larisa Fenenko [a] & Vitaliy Pokhodenko [b]

[a] Institute of Semiconductor Physics, National academy of sciences of Ukraine, 45, prospekt Nauki, 03028, Kyiv, Ukraine

[b] L.V. Pisarjevski Institute of Physical Chemistry, National academy of sciences of Ukraine, 31, prospekt Nauki, 03029, Kyiv, Ukraine

Version of record first published: 24 Sep 2006

To cite this article: Sergey Svechnikov, Petro Smertenko, Nikolay Guba, Ludmila Grebinska, Larisa Fenenko & Vitaliy Pokhodenko (2001): Peculiarities of Charge Flow in Polyepoxypropilcarbazol and its Derivatives, Doped by V_2O_5 and $SbCl_5$, Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals, 361:1, 119-123

To link to this article: http://dx.doi.org/10.1080/10587250108025728

Mol. Cryst. and Liq. Cryst., 2001, Vol. 361, pp. 119-123
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Peculiarities of Charge Flow in Polyepoxypropilcarbazol and its Derivatives, Doped by V_2O_5 and $SbCl_5$

SERGEY SVECHNIKOV[a], PETRO SMERTENKO[a], NIKOLAY GUBA[b], LUDMILA GREBINSKA[b], LARISA FENENKO[a] and VITALIY POKHODENKO[b]

[a]*Institute of Semiconductor Physics, National academy of sciences of Ukraine, 45, prospekt Nauki, 03028, Kyiv, Ukraine and* [b]*L.V. Pisarjevski Institute of Physical Chemistry, National academy of sciences of Ukraine, 31, prospekt Nauki, 03029, Kyiv, Ukraine*

Charge flow in the polymer structures on the base of polyepoxypropilcarbazol (PEPC) and PEPC with substitutes doped by V_2O_5 and $SbCl_5$ was studied. Two types of structures were used: gap and sandwich. Dark and light I-V characteristics were measured and treated by differential approach. The main peculiarities of investigated characteristics were: all characteristics had the regions $I \sim V^{\alpha}$ with α=(1.15–1.25); conductivity was enhanced with the doping concentration up to 5 times; the dark to light ratio K was over 100.

Keywords: Polyepoxypropilcarbazol; Doping; Charge flow; Conductivity

INTRODUCTION

Conductivity polymers are the promising materials for polymer electronics as not only a contact material and the base of diodes

including light emitted diodes [1]. Polyepoxypropylcarbazol (PEPC) is one of the most common carbazol polymers, which is widely used as an environment for reversible record of the information[2]. Doped PEPC was used as one of the layers for «hybrid» organic-inorganic photovoltaic converter, and also gauge of optical radiation for a wide spectral range[3,4]. However impurity doping effect on PEPC films is investigated not enough, especially accordingly increase of conductivity of such films.

The aim of this work is the investigation of peculiarities of charge flow and photoconductivity by differential technique[5,6] in the structures on the base of V_2O_5 and $SbCl_5$ doped PEPC films

EXPERIMENTAL

Poly-N-epoxypropylcarbazol and 3,6-dibrompolyepoxypropyl-carbazol were doped by V_2O_5 and $SbCl_5$ from 1m% to 50m%. Polymer films were fabricated by PEPC casting on the glass substrate with and without ITO. The film thickness was about 20 μm. Two types of structures were investigated: gap structure (the current direction is parallel to film surface) and sandwich one (the current direction is perpendicular to film surface). For sandwich structures the upper contact was evaporated in vacuum or holder In with $2 \cdot 10^{-2}$ cm^2 square. For gap structure the contact was soldering In.

Steady-state I-V characteristics were measured by standard technique in darkness and at 200 lx illumination of white light.

RESULTS AND DISCUSSION

Fig.1. shows I-V characteristics of undoped and doped PEPC.

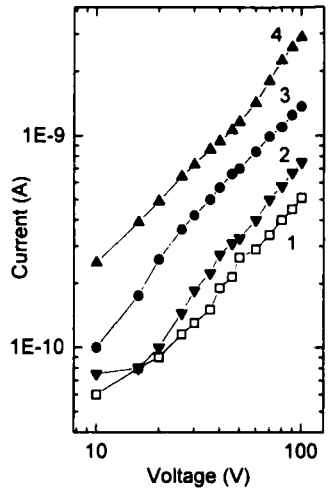

FIGURE 1 I-V characteristics of PEPC: 1- undoped; 2 - V_2O_5 (15m%); 3 - $SbCl_5$ (15m%); 4 - $SbCl_5$ (50m%).

From the Fig.1 one can see that increase of dopant concentration enhance the PEPC conductivity. Such increase is more for $SbCl_5$ dopant and achieve 5 times. Simultaneously with increasing of conductivity the photoconductivity enhance with dopant concentration increasing. But while the increase of conductivity is observed at low dopant concentration (~5 m%) the considerable ratio light to dark currents is achieved only at rather high one (~50 m%).

The using of differential treatment of I-V characteristics in the form of α=dlgV/dlgI allowed to discover the unusual behaviour: all characteristics had the regions $I \sim V^{\alpha}$ with α=(1.15-1.25) (see Fig.2.).

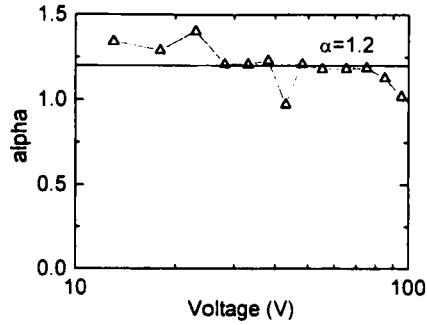

FIGURE 2 Typical differential slope of light current-voltage characteristic of PEPC doped by $SbCl_5$ (15 m%)

In the case of bimolecular or monomolecular recombination recombination α=1.5 and 2, respectively. In the case of space charge limited currents one can observe α=3 at high injection level in dielectric and α=2 for semiconductor (Child's low)[5, 6]. Such behaviour does not depend on bias polarity or type of dopant and can be an attribute of fractal[7].

There is another interesting feature. At low biases (- ITO) the light current is lower than dark one, and at high biases it is lower at opposite polarity. The same effect of abnormal behaviour of light currents is observed on $SbCl_5$ doped PEPC.

CONCLUSION

Thus, the new behaviour of I-V characteristics in PEPC doped by $SbCl_5$ and V_2O_5 has been recognized. All characteristics had the regions $I \sim V^{\alpha}$ with α=(1.15-1.25) which do not depend on bias polarity or type of dopant and can be an attribute of fractal. Conductivity of PEPC films was enhanced with the doping concentration up to 5 times at low concentration of doping impurities impurities V_2O_5 and $SbCl_5$ (~5 m%). The significant multiplisity of a light current to dark ratio is achieved at rather high one(~50 m%).

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