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OPTICAL AND ELECTRICAL CHARACTERISTICS OF TIO2 – MEH MULTILAYER'S THIN FILM

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ABSTRACT

The optical and electrical properties of TiO2-MEH-PPV double layer were studied when their number is increased. It was found that increasing the number of double layers decreases the energy gap which may result from the effect of the internal MEH electric field that allows some energy levels to enter the energy gap. The absorption also increases when layers were increased which may result from the narrowing of the energy gap. The current however decreases up on increasing the layers which may be related to the increase of electric resistance.

Keywords: Absorption, Energy gap, Current density, Layer.

I. INTRODUCTION

Transparent conducting oxides (TCOs) have a multitude of applications for solar energy utilization and for energy savings, especially in buildings. The largest of these applications, in terms of area, make use of the fact that the TCOs have low infrared remittance and hence can be used to improve the thermal properties of modern fenestration. Depending on, whether the TCOs are reflecting or not, they can serve in ‘‘solar control’’ or ‘‘low- remittance’’ windows in the near infrared pertinent to solar irradiation. Other applications rely on the electrical conductivity of the TCOs, which make them useful as current collectors in solar cells and for inserting and extracting electrical charge in electro chromic ‘‘smart windows’’ capable of combining energy efficiency and indoor comfort in buildings [1].Recently the interest in organic optoelectronic devices raised steadily owing to their interesting properties, such as low cost, mechanical flexibility, small weight. Indium tin oxide (ITO)is widely used as transparent anode in these devices. However there are some disadvantages of this (TCO). The limitation of its flexibility due to its ceramic structure can induce effects if it flexed too much. The indium scarcities involve high cost and are al shortage possibility. The deposition process of ITO needs sputtering and/or heating cycle, which has negative effect on the performances of organic devices, when it should be deposited on to the organic material. For all these reasons, there is a strong need to develop alternative transparent anode for organic optoelectronic devices [2]. A single-layered metal film is highly conductive. However, it is not transparent enough and less durable. A layer of (TCO) film was commonly deposited on to the metal layer in order to improve the transparency and durability. Compared with a single –layered TCO film, the multilayer coatings have much lower sheet resistance and much thinner thickness Transparent conductive films deposited on polymer substrates, because of lightweight, small volume, flexibility and easy carrying, are widely used in flexible electro-optical devices, flexible liquid crystal displays, plastic thin film solar cells and unbreakable heat reflecting mirrors[3]. Semiconductors have been used for centuries in electronics. Due to the presence of free carriers they are used extensively for applications which require high conductivity. Oxide semiconductors like ZnO, SnO_2, TiO_2, etc. possess high band gap (>3.2 eV) and are transparent in the visible region. Multilayers (ML) of these oxides with various metals give enhanced optical and

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magnetic properties than the corresponding doped systems. They have various applications in GMR, solar cells, etc. They are easier to manipulate to achieve required optical properties and are useful in applications like Plasmon lithography, UV band pass filters, gas sensors, photo catalyst, heat reflectors, eye protectors, etc. [4] B.A. Paez-Sierraa; and D.M. Marulandab (2016) investigate the Luminescence Tuning of MEH-PPV with Alq_3 and report that The intentional doping with the electron transport nanoparticleAlq_3 results in an additional band gap state of the hole transport MEH-PPV polymer and reduction of the switch on voltage of the organic LED display[5]. The optical and electrical properties of TiO_2 deposited on MEH by increasing number of composite layers are investigated in this work. Sections two, three and four are concerned with materials and methods beside discussion and conclusion.

II. MATERIALS AND METHODS

The organic compounds MEH-PPV and TiO_2wereused in this study to construct four samples which aremultilayers structures to study their optical and electrical characteristics .Poly (1,4-phenylene vinylene) PPV and its derivatives specially MEH PPV are widely used in the fabrication of organic light emitting diodes (OLEDs)[6] .MEH PPV is a very attractive conjugated polymer with an orange-red emission and can be easily dissolved in organic solvents and is useful for various applications and it has excellent luminescent properties[7]. Titanium dioxide (TiO_2) is the most suitable photocatalyst for widespread environmental applications because of its long-term stability against photo corrosion, excellent photocatalytic activity and strong absorption of harmful ultraviolet (UV) light. Due to the fact that a photocatalytic reaction occurs at the interface between catalyst surfaces and organic pollutants, it is highly feasible that the photocatalytic activity of TiO_2 is strongly dependent on its surface properties [8].We used MEH-PPV and TiO_2layer in our experiments to make four samples shown in fig (1). The four samples are formed from single , double or multi TiO_2 – MEH layers (TiO_2 – MEH , TiO_2 – MEH- TiO_2 – MEH , TiO_2 – MEH- TiO_2 – MEH TiO_2 – MEH and TiO_2 – MEH- TiO_2 – MEH- TiO_2 – MEH- TiO_2 – MEH) these layers were sandwiched between glass substrate and Ag electrode.

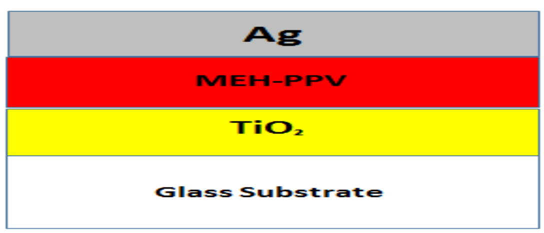

Fig (1) Schematic diagram of the device

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III. RESULTS AND DISCUSSION

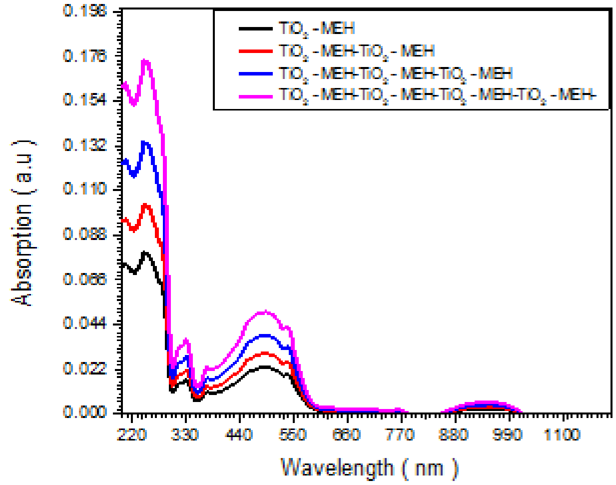

Fig (2) Absorption spectra of TiO_2 - MEH at different layers

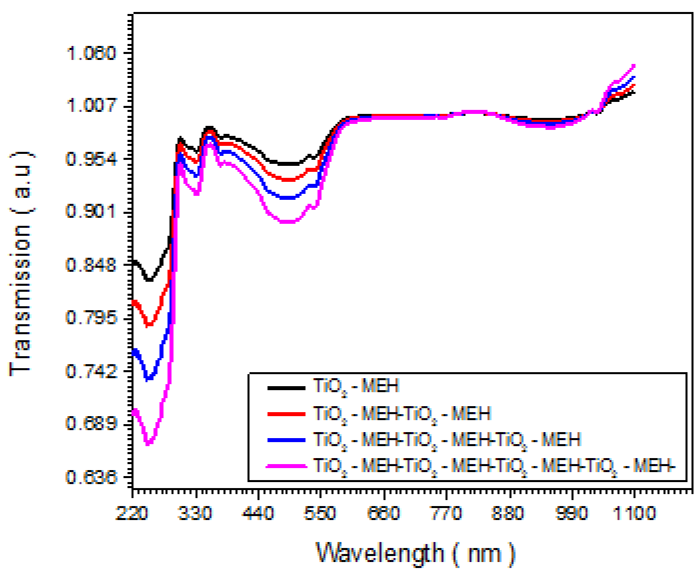

Fig (3) the transmittance in NUV/VIS/NIR spectra region

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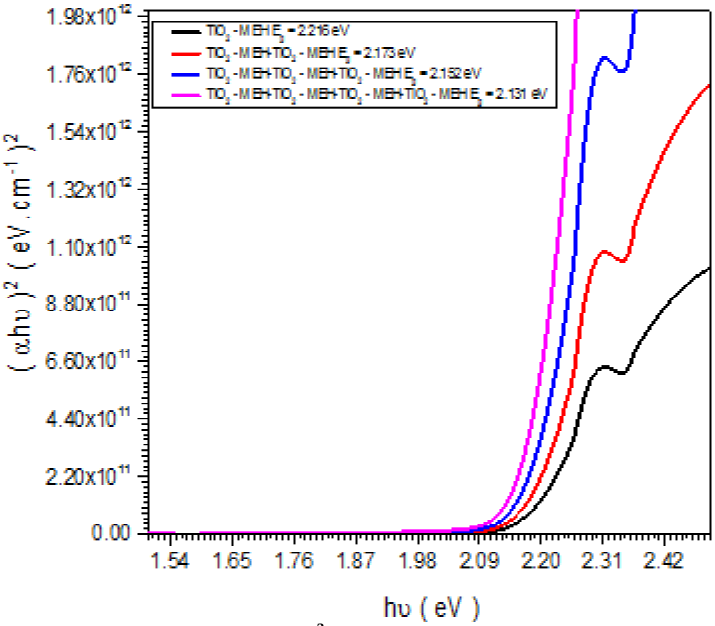

Fig(4) $(\alpha h\upsilon)^2$vs photon energy (hυ)

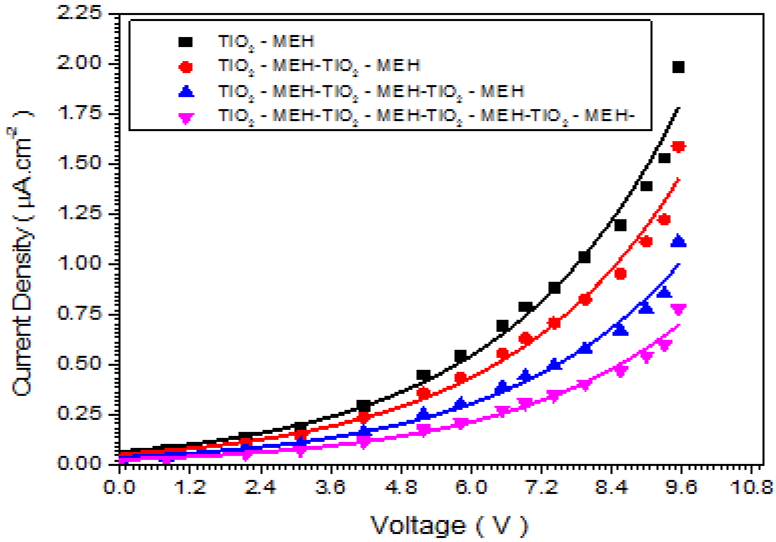

Fig (5) J-V characteristics of TiO_2- MEH multilayer film

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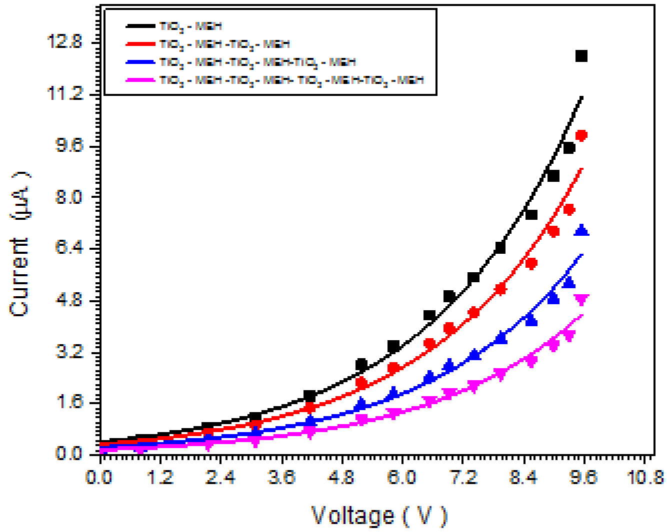

Fig (6) I-V Curves of TiO_2- MEH multilayer film

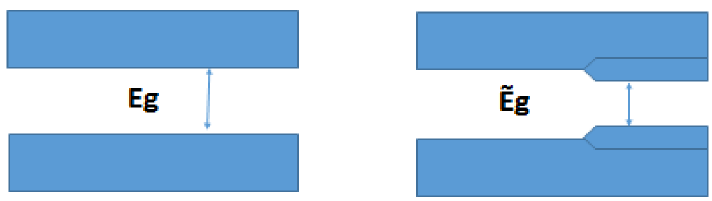

Fig (7) Energy gap before and after the electric field application

The absorption spectra for the four samples see Fig (2) show that the absorption incases as the double TiO_2 - MEH layers increases. This is quite obvious, since the increase of layers increase the number of MEH molecules that absorb light, which in the turn increases the absorption rate. The absorption peak wavelength increases very slightly upon increasing the number of layers. This means that when the number of layers were increased more long wavelengths were absorbed, which increases absorption rate. This conforms to the previous comment that increasing number of layers increases absorption. It is also very interesting to note that Fig (4) shows that the energy gap E_g decreases when the number of layers increase. This may be attributed to the fact that MEH layers are positively charged with holes. Thus each MEH layer is affected by the surrounding near by layers. This means that increasing MEH layers increases the electric field produced by them on certain specific layer [9]. According to stark effect this electric field causes splitting of energy levels [10]. Thus the bottom of the valence band and the top of the conduction band levels split into sub levels such that some of these sublevels enter the valence and conduction band, while some sublevels enter the energy gap as shown in the Fig (7) this lead to narrowing the energy gap to become E_g, such that ($\tilde{E}_g$<E_g). This decrease of energy gap when the number of layers increase , means that increasing layers decreases, energy gap which gives chances to more low energy photons to be absorbed , thus increases absorption rate . This result is consistent with the absorption spectra in Fig (2) which shows that increase of number of layers increases absorption. Finally Fig (5) and (6) shows that both current density and current decreases upon increasing the number of double TiO_2 - MEH layers. This decrease may result from the fact that increasing layers increases electric resistance which in turn decreases current density and current.

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IV. CONCLUSION

The energy gap of TiO_2 - MEH double layer can be decreased and the absorption can be increased by increasing the number of them. Thus increase of TiO_2 - MEH layers decreases current.

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