1. Introduction

Organic light-emitting diodes (OLEDs) are light-emitting devices subject to ongoing research. They are structured in several layers of organic materials. When an electric field is applied to the cathode, light is emitted as the electrons generated at each pole meet the holes [1]. Except for special cases, OLED devices have an inherent ability to emit light even on the surface of materials given the presence of thin films of such structures, thus allowing the production of more flexible designs compared to conventional light-emitting devices, with a multitude of advantages, ranging from higher color expression to wider viewing angles than conventional devices [2]. Current OLED displays consist of a hole injection layer (HIL), hole transport layer (HTL), emissive layer (EML), electron transport layer (ETL), and electron injection layer (EIL), as well as a layer that assists in the efficient transport of holes and electrons via the addition of an interlayer and a layer in which the electrons and holes meet to produce light emission [3]. Self-emitting organic materials emit light upon application of electricity based on â€œelectroluminescenceâ€•. The excitation state is temporarily unstable and the return to the â€˜ground stateâ€™ is immediate, since electrons seek to find a stable state. As electrons return from the excited state to the ground state, the energy level decreases back to the original level, when the reduced energy is emitted in the form of light.

2 O 3) and tin oxide (SnO 2). ITO is widely used in the fabrication of displays, electronic paper, OLED, architecture, solar cells, and protective coatings due to its electrical conductivity, optical transparency, excellent substrate adhesion, high-temperature resistance, ability to form thin films, and chemical resistance to moisture [The most-applied material used as the anode in the fabrication of OLED devices at present is indium tin oxide (ITO) on a glass substrate for transparent electrodes [4]. ITO is a type of transparent conducting oxide material composed of indium oxide (In) and tin oxide (SnO). ITO is widely used in the fabrication of displays, electronic paper, OLED, architecture, solar cells, and protective coatings due to its electrical conductivity, optical transparency, excellent substrate adhesion, high-temperature resistance, ability to form thin films, and chemical resistance to moisture [5].

2) at driving voltages less than 10 volts in 1987 [Tang et al. reported the HTL of an OLED device could be modified to improve performance by reducing the driving voltage, which was the first work to modify the deviceâ€™s interlayer. Tang et al. achieved quantum efficiency (1% photon/electron), luminance efficiency (1.5 lm/W), and brightness (>1000 cd/m) at driving voltages less than 10 volts in 1987 [6]. Additionally, the light emitting layer was doped with other substances in 1989, which increased efficiency by more than two fold compared to the previous work done at driving voltages less than 10 volts [7]. Significant improvement in electron injection was achieved by introducing a thin LiF film and reducing the electronic barrier of the organic/AI interface layer, further improving the efficiency of the device [8]. In recent years, there has been intensive research into the modification of the inner layer of the device,

aiming to create high-brightness, high-efficiency, low-power, and commercial technologies.

The most well-known studies on the HIL layer involve using materials such as PEDOT:PSS, 2-TNATA, MoOx [9 10] and SAM, while those on the HTL layer report on the use of TCTA, TPD, and m-MTDATA [11]. The two layers act to improve the efficiency of hole injection to the subsequent layer by increasing the highest occupied molecular orbital (HOMO) level [12].

18,19, Self-assembled monolayers (SAMs) are organic monolayers with an intrinsic nanostructure that are formed at phase boundaries [13]. They are advantageous in inducing a change in the substrate, as the SAM film coating on the surface of an existing solid material may provide lubrication or prevent oxidation [14]. Based on these characteristics, SAMs have been actively and continuously studied since their first introduction by Bigelow and Zisman in 1946 [15]. The structure of SAMs has a head group that can bind to the surface of a solid material, an alkyl chain at the center of the molecular structure, and a functional group with a final role in the molecular membrane. The film is formed through hydrolysis and polymerization involving the head group on a solid surface [16]. In recent years, research has focused on the improvement of the performance of OLEDs using SAM [17 20]. Fluorinated organic compounds are widely used for improving the efficiency of organic light-emitting devices owing to fluorine exhibiting a large electric dipole moment [21]. Additionally, in the field of medical devices and research, significant work has been done in recent years to develop OLED systems based on ITO and improve luminance and its impact on the human body and health [22]. The healing phenomenon occurs at the sites via a photobiological reaction depending on the depth through the human body in the spectrum between 300 nm and 830 nm [23]. An OLED device in photomedicine is engaged during mitochondrial ATP production at specific wavelength bands of PBM. This method is applied in the fields of biological and medical sciences for wound healing and the reduction of pain and inflammation, among other applications. Such methods are increasingly being used in LED and laser treatments, and recently, a PBM therapy using OLED-based flexible materials has been widely utilized [24 25]. Long-term use is essential to obtain the PBM effect in optimal conditions [26].

Reference

Face-to-Face Dialogue: Theory, Research, and Applications (FOUNDATIONS OF HUMAN INTERACTION)

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