Application of Carbon Nanotubes in Displays

T.Feng, Z.Sun, Z.J.Zhang, L.F.Lin, Hui.Ding, Y.W.Chen, L.K.Pan*
Engineering Research Center for Nanophotonics & Advanced Instrument,
Ministry of Education, East China Normal University
North Zhongshan Rd. 3663, Shanghai 200062, China
Phone: 86-21-62234322, E-mail: tfeng@phy.ecnu.edu.cn

Abstract

Since the discovery over a decade ago, carbon nanotubes (CNTs) have been attracting considerable attentions both from scientists and engineers. Because of the excellent field emission properties, such as high aspect ratio, extremely small diameter, and high emission current, CNTs become a potential candidate as field emitter for field emission display (FED) and lighting (FEL) as backlight for LCD. Due to the exceptional physical properties, such as superior thermal and electrical conductivities, as well as high stiffness and strength, the CNT-based composites can be as light-weight heat-sink or thermal spreader materials used for power electronic devices, such as power LED for general illumination. The CNTs for above applications will be reviewed, and related materials and devices will be demonstrated in this paper.

1. Introduction

Carbon nanotubes (CNTs) are unique nanostructures with remarkable electronic and mechanical properties, some stemming from the close relation between carbon nanotubes and graphite, and some from their one-dimensional aspects. CNTs have attracted the fancy of many scientists world-wide. In this paper, we describe some applications of CNTs in displays including in field emission display (FED), LCD and LED.

2. Applications of CNTs in FED and LCD

CNTs is a potential candidate as field emitter for field emission display (FED) and field emission lighting (FEL) as backlight for LCD. CNTs have the right combination of properties – nanometer-size diameter, structural integrity, high electrical conductivity, and chemical stability – that make good electron emitters [1,2]. Electron field emission from CNTs was first demonstrated in 1995 [2], and has since been studied intensively on various carbon nanotube materials. Samsung, Ise, Futuba and Sony etc. all focus on the development of CNT-FEDs.

Recently, a 4 inch diode-type FED module has been fabricated in our group using CNTs as the electron emission source. The schematic depiction of diode-type CNT-FED module was shown in Fig.1e. The unit consists of two glass plates: one is CNT cathode plate (Fig.1b) with screen-printed CNT films on patterned Ag electrodes; the other is phosphor anode plate (fig.1d) with phosphors on patterned ITO electrodes. The size of the unit is 98 × 98 mm with 16 × 16 matrix arrays of pixel, and each pixel is sized of 4 × 4mm. The anode–cathode space was maintained using some glass spacers placed among pixels. Ag electrodes were perpendicular to ITO electrodes, and thus makes matrix addressing possible by progressive scan. At a cathode-anode gap distance of 100μm, 280 V is required to obtain the emission current density 1mA/cm^2. With piling-up technology, a 40 inch large-size display has been obtained using our FED module as shown in Fig.2.

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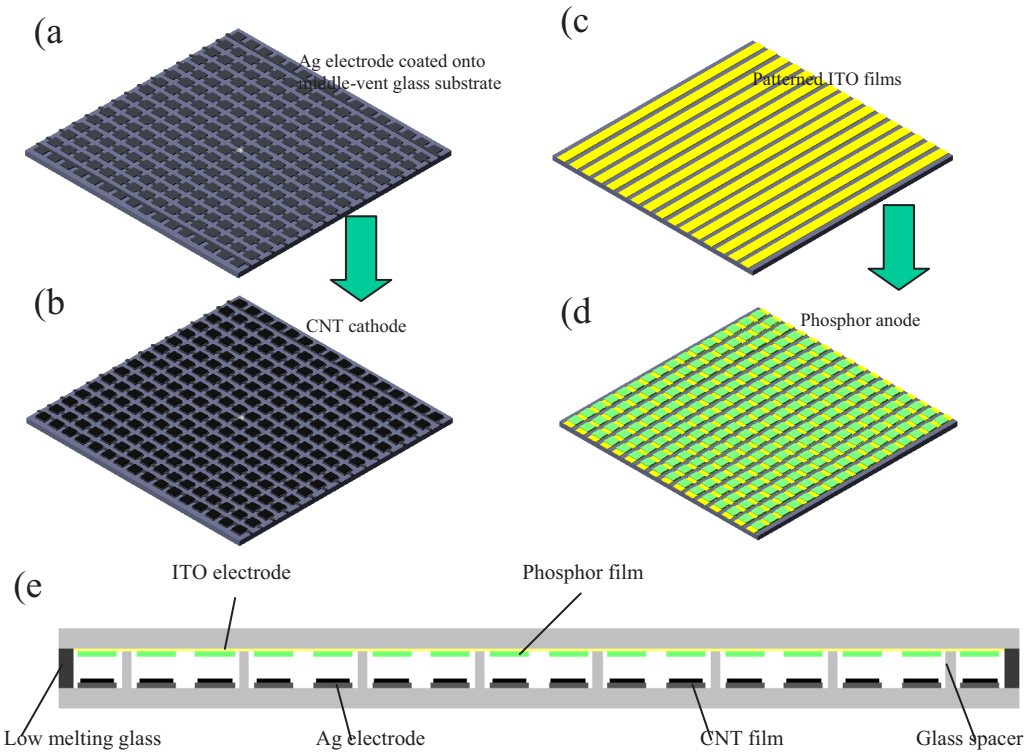

Fig1. Schematic depiction of (a) Ag electrode coated onto middle-vent glass substrate (b) CNT cathode, (c) Patterned ITO films, (d) phosphor anode and (e) CNT-FED module

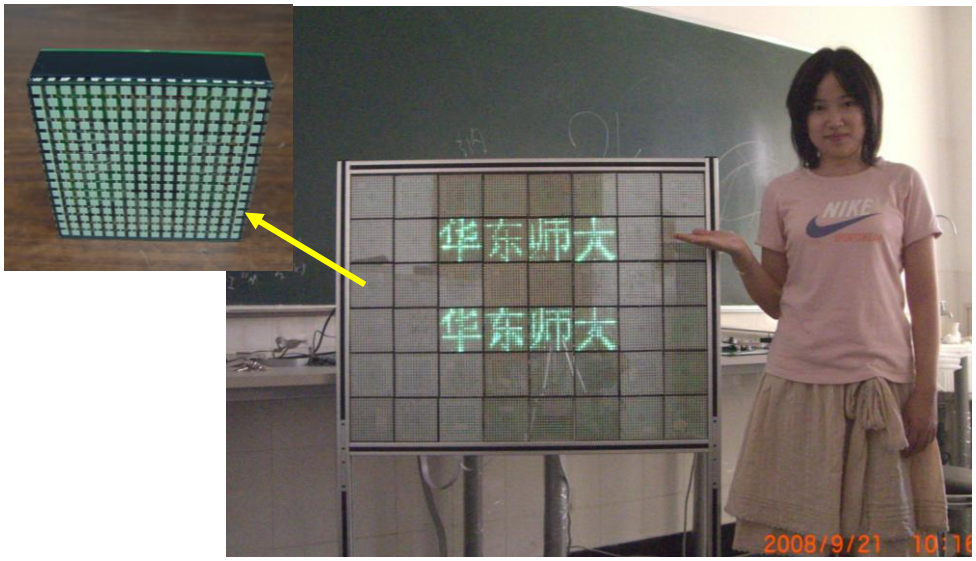

Fig2. A 40 inch large-size field emission displays based on piling-up technology.

3. Applications of CNTs in LED

In high power LED packages for solid-state lighting, effective heat dissipation is needed to meet the increasing requirements on the efficiency, color, and the product life time [1]. Carbon nanotube (CNT) is an attractive candidate materials to improve the thermal performance of high power LED because of their ultrahigh thermal conductivity about 600~3000 W/m·K [3-4].

In this paper, we proposed an effective package design for high power LED as shown in Fig.3. The normal Ag paste mixed with CNT powder was used as heat transporter. The well aligned CNT films was the thermal sinker. The C/CNTs/CNFs was used as heat spreader.

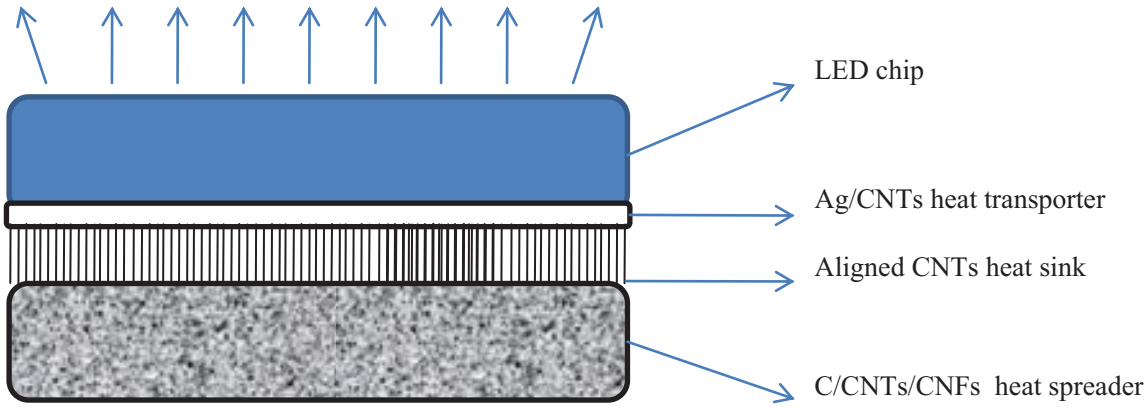

Fig.3 Effective Package design of high power LED

4. Acknowledgements

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