Electrode Formations for the External Electrode Fluorescent Lamps

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Abstract

Electrode formation methods such as a metal-taping, a electrolytic plating, and a metal-paste melt-bonding, are introduced for an external electrode fluorescent lamp. The characteristics of luminance and efficiency for various external electrode types have been investigated.

1. Introduction

External electrode fluorescent lamps (EEFLs) [1-3] have been developed for longer life than cold cathode fluorescent lamps (CCFL). These might be good merits as a light source of a backlight panel. It is simple manufacturing process and assembling with EEFLs since it has no electrode inside glass tube. In CCFLs, the connection of glass and metal electrode inside could be damaged mechanically .

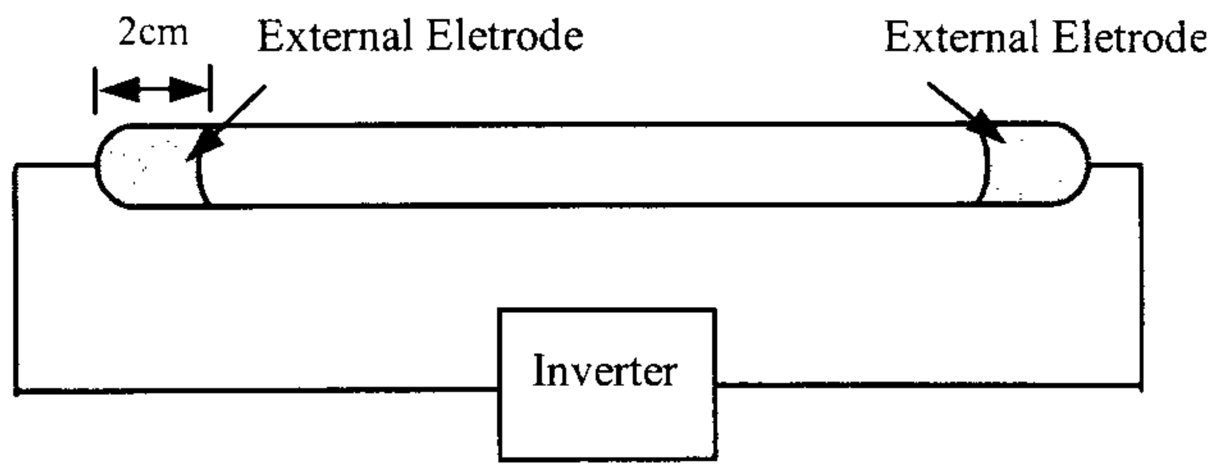
Recently, a direct light backlight using EEFLs for LCD TVs and monitors have achieved a high brightness and efficiency, and this makes a possibility in commercial applications.

In this study, several methods of an external electrode formation are introduced. A simple one is metal-taping on the lamp tube with copper or aluminium foils, while the reliability is low in taping adhesion. An electrolytic plating and a new method of metal-paste melt-bonding are investigated with the luminance characteristics of EEFLs.

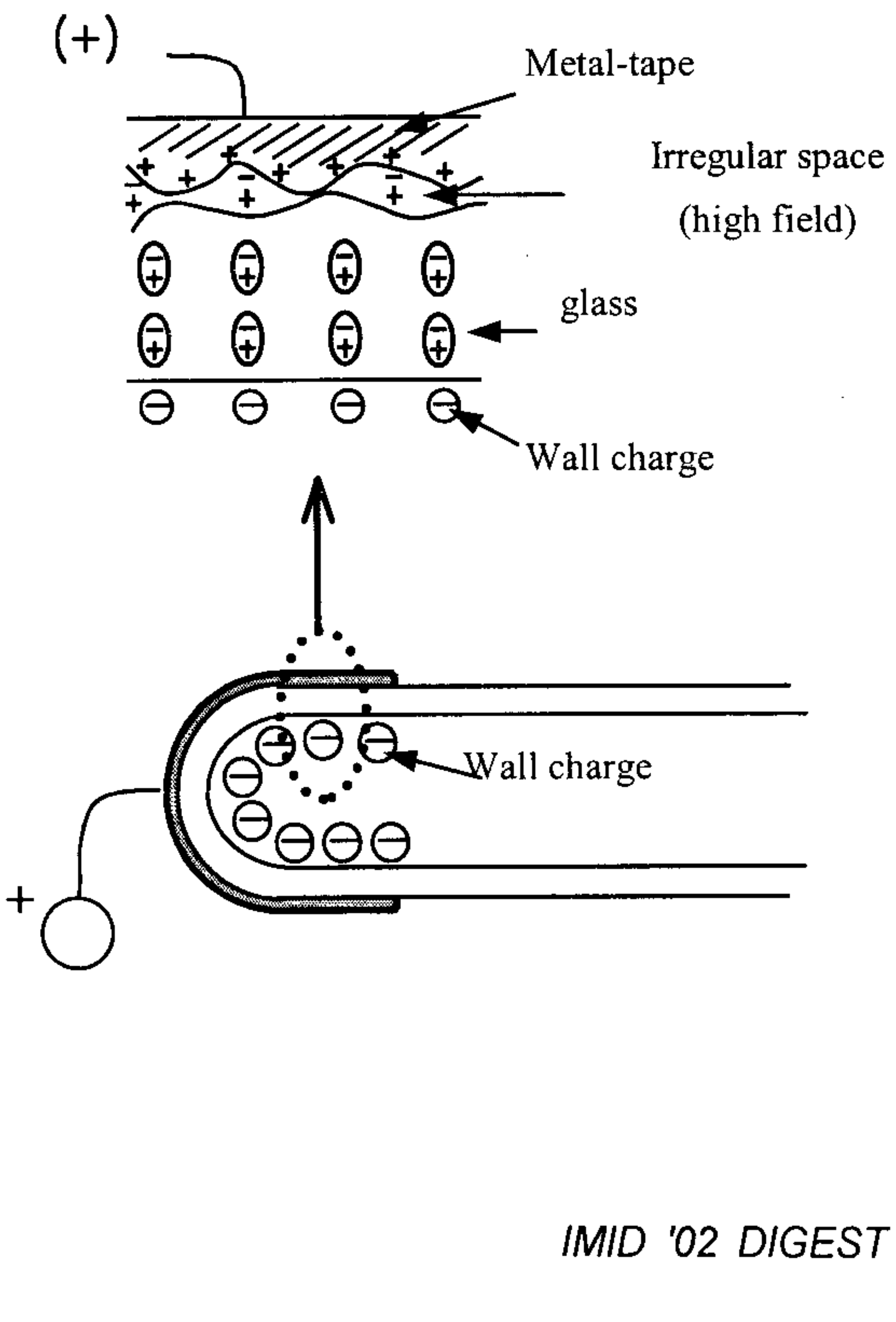
2. Electrode Formation Method

Fig. 1 shows the concepts of EEFL lamps(a) and the structures of electrode formation(b,c) at the ends of the lamp. The metal-tapping is shown in Fig. 1(b). Cu or Al foils are taped on the outer ends of the lamp. Fig. 1(c) shows a metal-paste melt-bonding method. The metal-paste compound materials of a dense liquid mixed with a metal powder, a binder and a solvent, etc. The end of lamp are dipped or liquid metals pasted and annealed by high temperature, then the electrodes are formed as shown in Fig.1(c). The liquid Ag and Al-paste are used in this study. The thickness of the electrodes can be controlled by the powder density in the liquid, from several microns to tens of microns.

a)



b) **Metal - taping**



c) **Matal – paste melt - bonding**

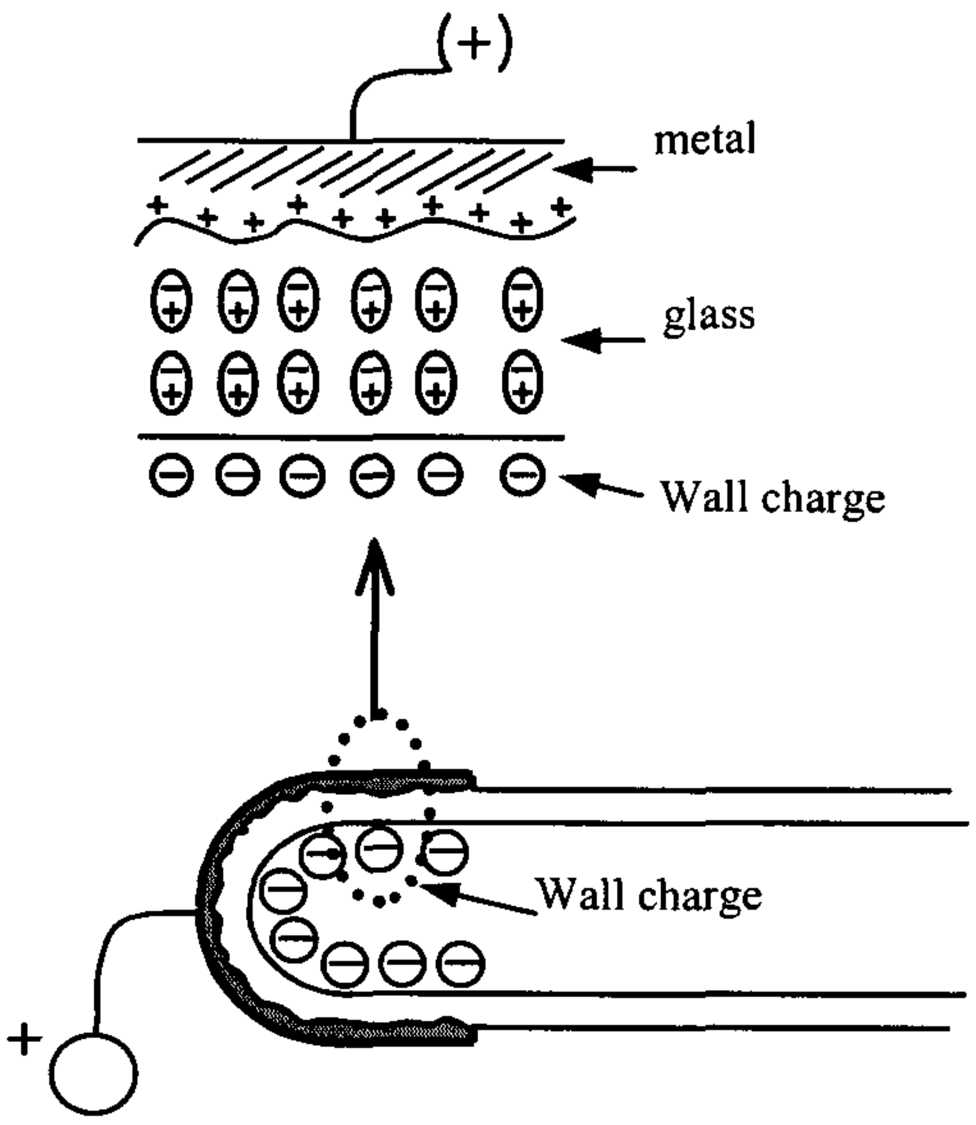


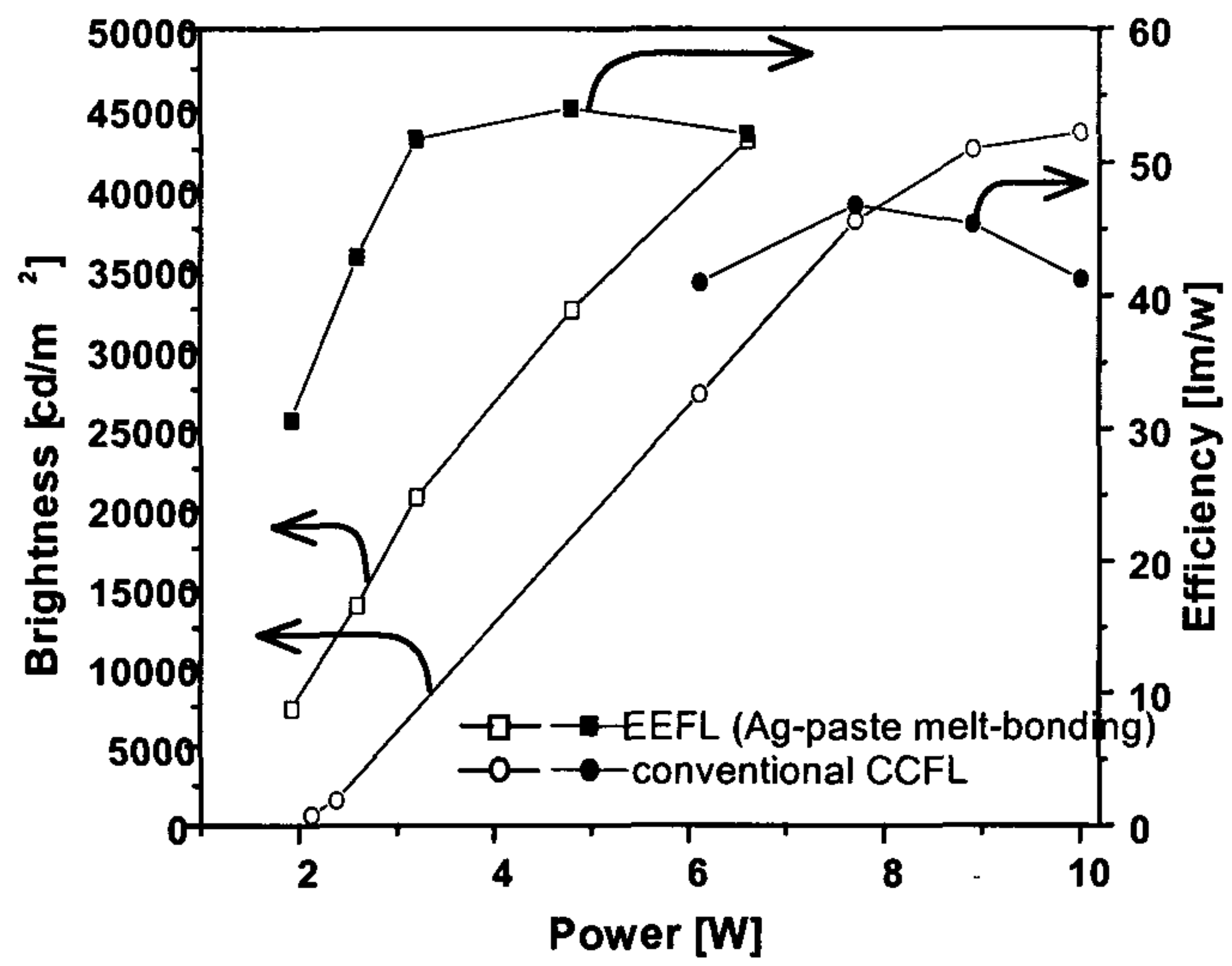
Figure 1. The concepts of EEFL lamps (a), metal-taping (b) and metal-paste melt-bonding (c).

The taped electrodes have the irregular spaces having a capacitance between the glass and electrodes, and this makes the high electric field gap and lower capacitance coupling. But metal-doped one has no air gap and electrode coupling of the EEFL increased, and so more reliability of the lamp applications. Particulary the adhesive strength in a melt bonding is so strong that the surface of metal electrode is not stripped off by scratching even with a sharp knife.

3. Luminance Characteristics

Fig.2 shows the comparison of the brightness and the efficiency for the EEFL of melt-bonded Ag electrode and for the conventional CCFL. The inverters of EEFL Lamps supply the high voltage square wave by the switching inverter of the full-bridge circuits for the high speed on-off controls. The conventional CCFL is operated with LC resonant inverter in this experiment. The length of lamp is 352 mm with the electrode length of 20mm and outer diameter of 2.6 mm in this study. CCFL shows 25,000 cd/m^2 brightness and about 40 lm/W efficiency at 6 watts, but EEFL has 40,000 cd/m^2 and 55 lm/W at 6 W, better efficiency than CCFL lamps.

a)



b)

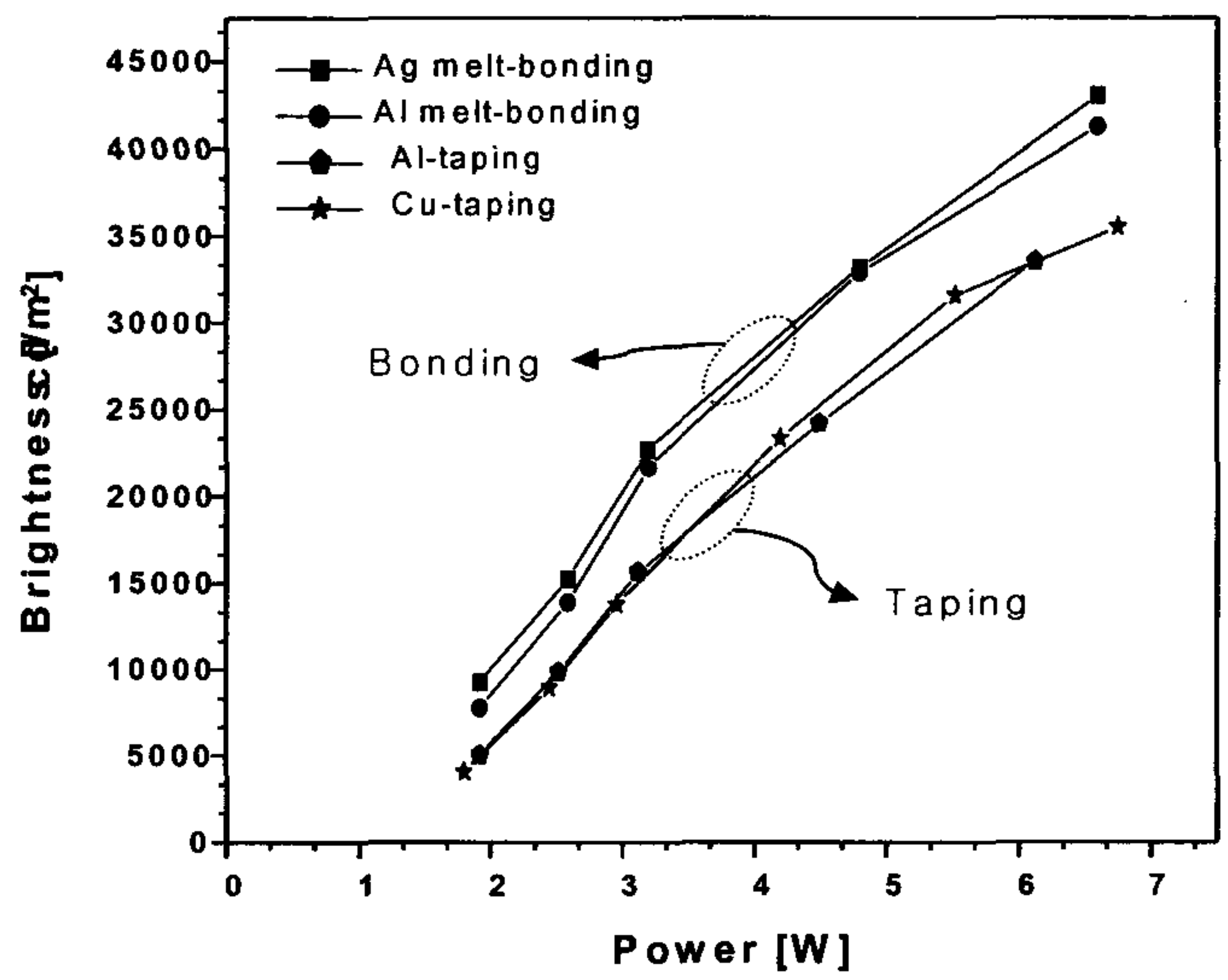


Figure 2. The brightness and efficiency versus power for the single EEFL of Ag-paste melt-bonding and a conventional CCFL (a). EEFL is driven by a switching inverter and CCFL is operated by a LC-resonant inverter. And the brightness versus power for various types of external electrode of EEFLs driven by a switching inverter (b).

The brightness and the efficiency of EEFL are shown in Fig.2 (b) for the various formation methods of external electrode. These are Ag and Al metal-paste melt-bonding, Ni electrolytic plating, Cu tapped and Al tapped. The EEFLs of metal-paste melt-bonding show higher luminance and efficiency than others of electrolytic plating and taping.

4. Results

The brightness and efficiency characteristics are investigated by the different electrode formations of EEFL. The metal-paste melt-bonding method makes strongly to be coupled to the glass of lamp and increased the capacitance of electrode. This can be more efficiency in a dielectric barrier discharge.

5. References

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