# Inverted Top-emitting Organic Light-emitting Diodes with a Multilayered Graphene Top Electrode

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Organic light-emitting diodes (OLEDs) have recently received peculiar attention as a next display and various products using OLEDs panels are released on the market. Especially, top-emitting (TE) OLEDs are of great interest because they have several advantages for active-matrix (AM) OLED displays such as diversity of substrate selection and large aperture ratio for high-resolution displays.[1] However, transparent top electrode is one of critical issues in TEOLED. Semitransparent thin metals and transparent conductive oxides (TCOs) are used as a top electrode in TEOLED, but thin metals have low transmittance in visible spectral region, causing low efficiency and color distortion depending on the viewing angles and TCOs deposition process for top electrode can cause degradation of top organic layer in TEOLEDs.[2, 3]

The graphene is transparent and theoretically very conductive as well as metal-free material, leading to reduce surface plasmon losses.[4, 5] In this work, we have fabricated inverted TEOLEDs by introducing multilayered graphene (MLG) as a top electrode as shown in Fig. 1. For laminating the MLG layer on the top organic layer in TEOLED, we use a bonding and a supporting layer which can be called graphene electrode tape (GET). The MLG/bonding layer/supporting layer structure is very transparent as shown in Fig. 1. In addition, this MLG electrode is electrically connected to the top organic layer in phosphorescent yellowish-green TEOLED which demonstrates high efficiency of about 47 cd/A at about 1000 cd/m$^2$ as shown in Fig. 2. We also investigate EL spectra of the white inverted TEOLEDs with a MLG top electrode depending on viewing angle.

Above result is first reported TEOLEDs with graphene top electrode and we believe that this graphene electrode can be used various optoelectronic devices such as solar cells, quantum-dot devices as well as OLEDs.

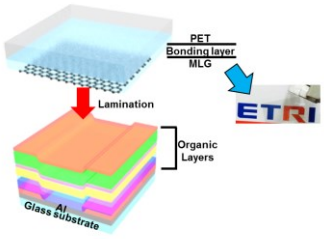


**Fig. 1. GET-organic lamination process and structure of inverted TEOLED.**

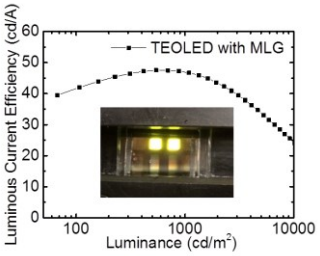


**Fig. 2. Luminous current efficiency-luminance characteristics of the device (Inset: images of yellowish-green EL).**

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