Enhancement of carrier injection for polymer light emitting diode by incorporating gold nanoparticle in luminescent polymer

Ten-Chin Wen, Sung-Nien Hsieh, Chin-Yu Chan and Li-Ming Huang
Department of Chemical Engineering, National Cheng Kung University Tainan, 701, TAIWAN

E-mail:tcwen@ncku.edu.tw

Light emitting diodes (LEDs) based on conjugated polymers have been extensively studied due to their potential applications in flat panel displays [1]. The LED performance, both light output and efficiency, is critically dependant on the balanced injection of charge carriers, which can be obtained by promoting either the charge injecting ability or the charge confinement [2] for bipolar recombination. The operation of LEDs generates spin-symmetric triplets and spin-antisymmetric singlets in the ratio of 3:1 [3], but the energy of the triplet excitions is wasted via nonradiative decay process. The utilization of nanoparticles in optoelectronic devices often enhances the optical and electrical properties. Approaches to enhance the performance of PLEDs by incorporating SiO_2 and nano metals [4] have been reported recently.

Herein, we report the fabrication of a yellow PLED with enhanced power efficiency by incorporating 5-10 nm gold nanoparticles as the quenches of the triplet states of SY-PPV. The PLEDs with the following configurations were assembled: ITO/PEDOT/SY-PPV (contain gold nanoparticles/ without gold nanoparticles/Ca/Al.

In order to know the role of the gold nanoparticles in the device performance, current-voltage-luminance characteristics of all the devices are measured (Fig.1). One of the interesting phenomena observed here is the drastically increased current and luminance when a volume fraction of nanoparticles of 2×10^{-4} was incorporated into the luminescent polymer, suggesting that the addition nanoparticles enhance the carrier injection or mobility. However, the more gold nanoparticles incorporated in luminescent polymer result a decrease in both current and luminance. The reason is that the more gold nanoparticles in the luminescent polymer might further increase the hole blocking effect of the nanoparticles which start to dominate their electron injection effect and result low luminance. By the way, the turn-on voltage did not change with incorporation of gold nanoparticles in luminescent polymer. Therefore, gold nanoparticles play a major role for the enhancement of power efficiency of the PLEDs. Besides, further studies to know the effect of the gold nanoparticles and understand the mechanism of operation for the nanoparticle modified light emitting diodes, should be carried out.

References

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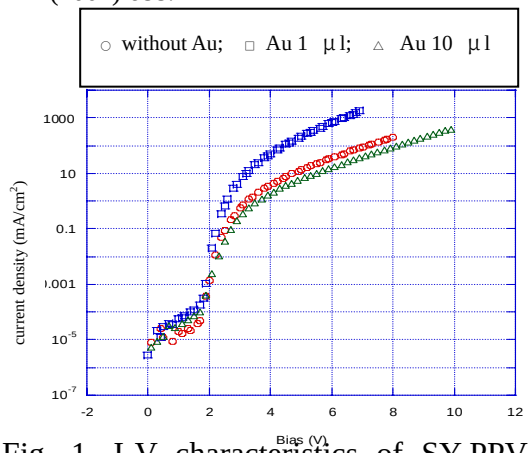

Fig. 1. I-V characteristics of SY-PPV nanocomposite devices with various fractions of gold nanoparticle

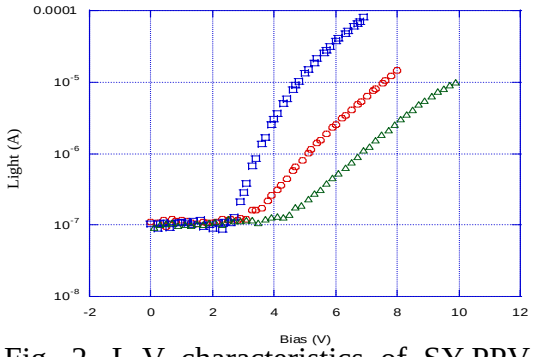

Fig. 2. L-V characteristics of SY-PPV nanocomposite devices with various fractions of gold nanoparticle.