Organic and Colloidal Quantum Dot based Optoelectronic Devices: Photovoltaic Cell and Light Emitting Diode

***Do Kyung Hwang*[1], *Tae-Hee Yoo*[1], *Hong Hee Kim*[2], *Choong Hyo Kim*[2], *and Won Kook Choi*[2]**
1Center for Opto-Electronic Materials and Devices, Korea Institute of Science and Technology (KIST), Seoul, Korea

Email:dkhwang@kist.re.kr

2Future convergence research division, Korea Institute of Science and Technology (KIST), Seoul, Korea

Organic semiconductors and colloidal quantum dots (QDs) based optoelectronic devices such as photovoltaic cells and light emitting diode have attracted considerable attention as a promising technology for cost-effective renewable energy source, next generation displays, and solid-state lighting.

In the first part of this talk, we will discuss Ag nanowire mesh film that has been used as a transparent electrode in fabrication of flexible P3HT:PC_{60}BM and PTB7:PC_{70}BM Organic solar cells (OSCs).[1] Compared to the reference devices with ITO electrodes, the devices with Ag NW mesh electrodes showed the higher J_{sc} of 12.15 ± 0.10 mA/cm^2 for P3HT:PC_{60}BM and 19.16 ± 0.86 mA/cm^2 for PTB7:PC_{70}BM, resulting in the enhanced PCE of 4.45 ± 0.02 % and 7.58 ± 0.40 %, respectively. These improvements were correlated with the enhanced light absorption in the active layer due to the light scattering and light trapping effect induced by the Ag NW mesh, which was confirmed by EQE spectra (Fig. 1), a haze factor measurement and FDTD simulations.

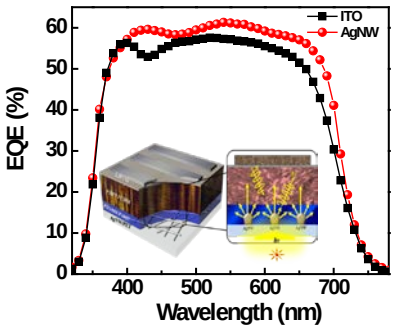

Figure 1. EQE spectra of a P3HT:PC60BM OSC with the Ag NW mesh electrode and the reference device with the ITO electrode

In the second part of this talk, we will report on a polyethylenimine ethoxylated (PEIE) modified ZnO nanoparticles (NPs) as electron injection and transport layer for inverted structure red CdSe-ZnS based quantum dot light emitting diode (QDLED).[2] The PEIE surface modifier, incorporated on the top of the ZnO NPs film, facilitates the enhancement of both electron injection into the CdSe-ZnS QD emissive layer by lowering the workfunction of ZnO from 3.58 eV to 2.87 eV and charge balance on the QD emitter. As a result, this device exhibit a low turn-on voltage of 2.0-2.5 V and have maximum luminance and current efficiency values of 8600 cd/m^2 and current efficiency of 1.53 cd/A, respectively. The same scheme with ZnO NPs/PEIE layer has also been used to successfully fabricate green, blue, and white QDLEDs (Fig. 2).

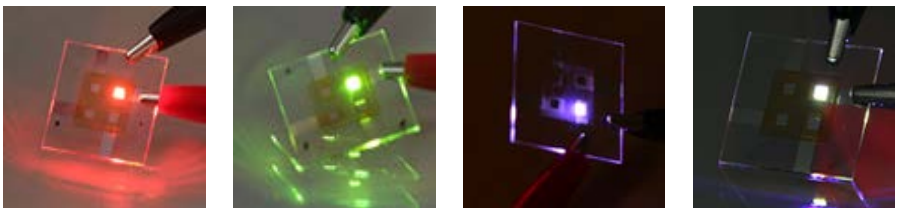

Figure 2. All color QDLEDs adopting the ZnO NPs/PEIE layer.

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References

1. B. Wang , T. Yoo , J. Lim, B. Sang ,D. Lim , W. K. Choi, D. K. Hwang, Y. Oh, *Small* DOI: 10.1002/smll.201402161 (2015).
2. H. H. Kim, S. Park, Y. Yi, D. S. Son, C. Park, D. K Hwang, and W. K. Choi, *Sci. Rep.* **5**, 8968; DOI:10.1038/srep08968 (2015).