Solution-Processed Phototransistors Based on Small Molecules Semiconductors/All-Inorganic Perovskite Quantum Dots Blends

Shao-Huan Hong(洪紹桓)[1], Ming-Chou Chen(陳銘洲)[2,*], and Cheng-Liang Liu(劉振良)[1,*]

[1]Department of Chemical and Materials Engineering, National Central University, Taoyuan, Taiwan
[2]Department of Chemistry, National Central University, Taoyuan, Taiwan
E-mail: [2]mcchen@ncu.edu.tw; [1]clliu@ncu.edu.tw

Abstract

Perovskite quantum dots have been used in photoelectronic device because of some advantages, such as high pure color emission and solution processability. However, due to the poor intrinsic property of charge transfer, the development of perovskite quantum dots in phototransistors is in limitation. In this study, all-inorganic $CsPbBr_3$ perovskite quantum dots blended with dithienothiophenoquinoid (DTTQ) small molecule were used as the semiconductor layer of phototransistors. Even if the concentration of perovskite quantum dots increased, we could still get the good crystalline film of small molecule. This result could be attributed to using the solution-shearing method instead of spin-coating method.

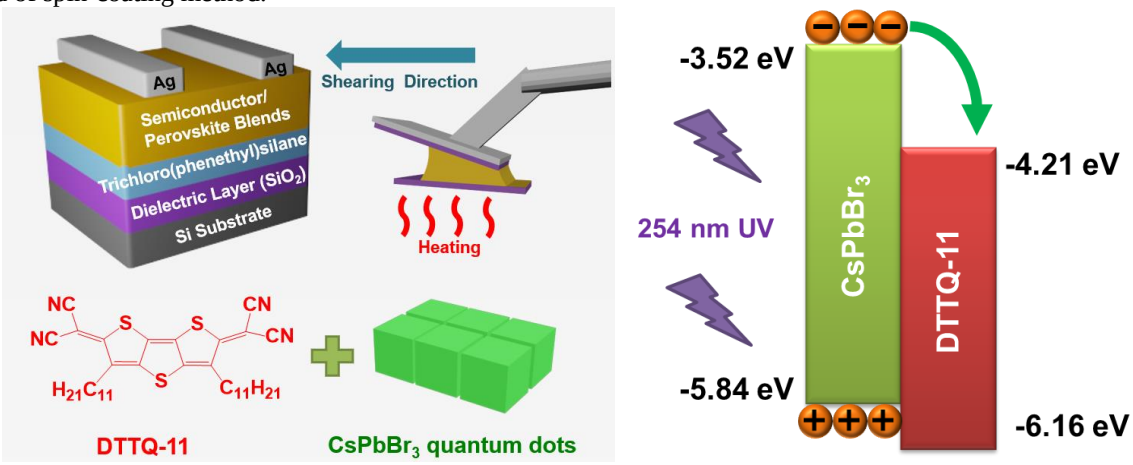

Figure 1 Schematic diagram of the experiment and energy level diagram of blending structure.

The all-inorganic perovskite quantum dots/small molecules semiconductor blends phototransistors with bottom-gate-top-contact architecture showed the elastic performance. Through the tunable precursor concentration and gate voltage, we could get the best device performance, such as photoresponsivity (213.34 A W^{-1}), photosensitivity(1.52 x10^4) and detectivity(1.97x10^{11} Jones), which was tested under the 254 nm UV light illumination. In addition, the good crystallinity of DTTQ semiconductor also played an important role in these results due to superior charge transfer. These findings give a potential of developing high performance phototransistors with simple solution process.

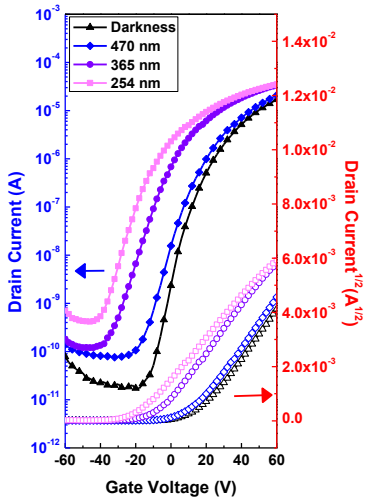

Figure 2 Transfer curve of darkness and illumination.

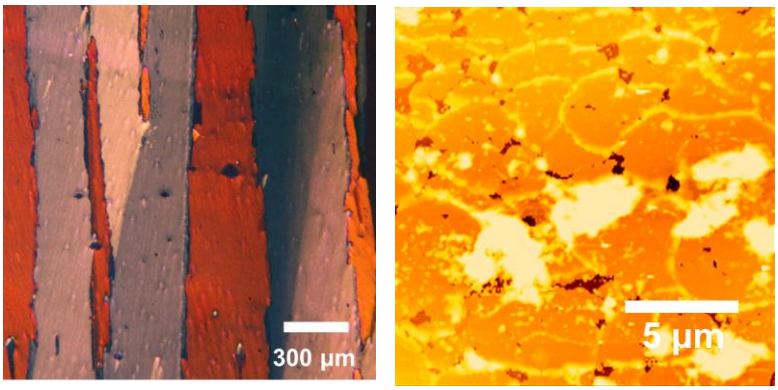

Figure 3 POM and AFM image of blending structure.

Keywords – solution process, organic semiconductors, perovskite quantum dots, blends, phototransistors.