Bulk Heterojunctions of Cesium Lead Halide Nanocrystals with Fullerene Derivatives for Light Harvesting Applications

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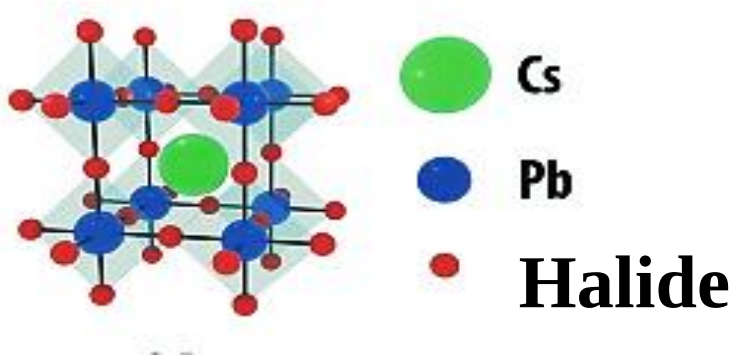
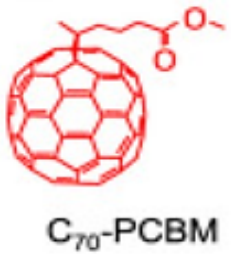
Materials





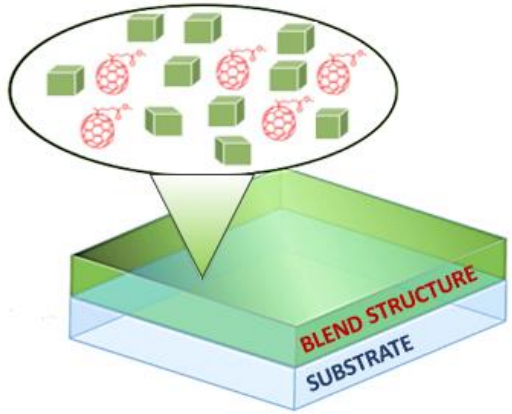


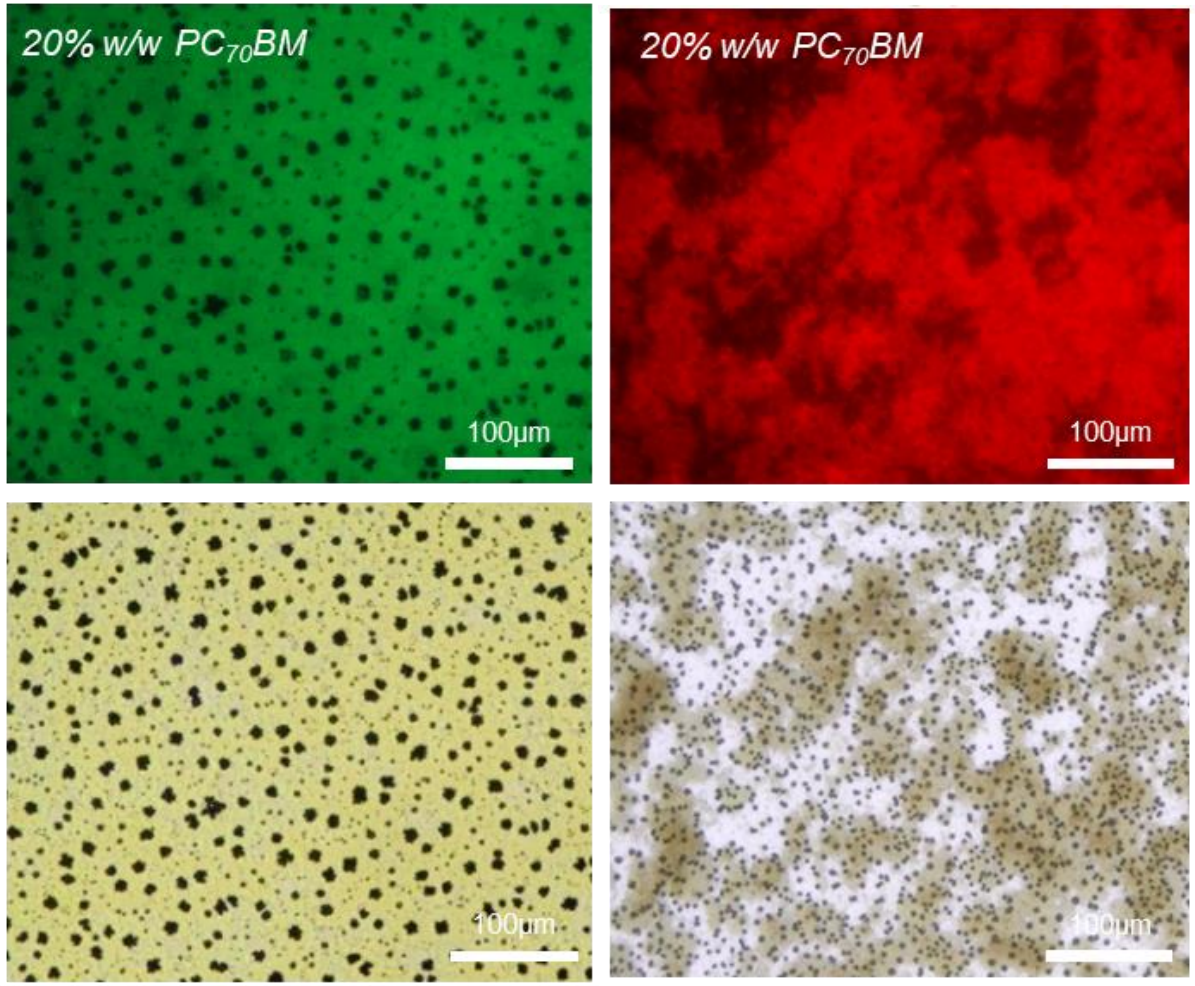
Figure: Materials under study :
(a)Perovskite crystal structure sample

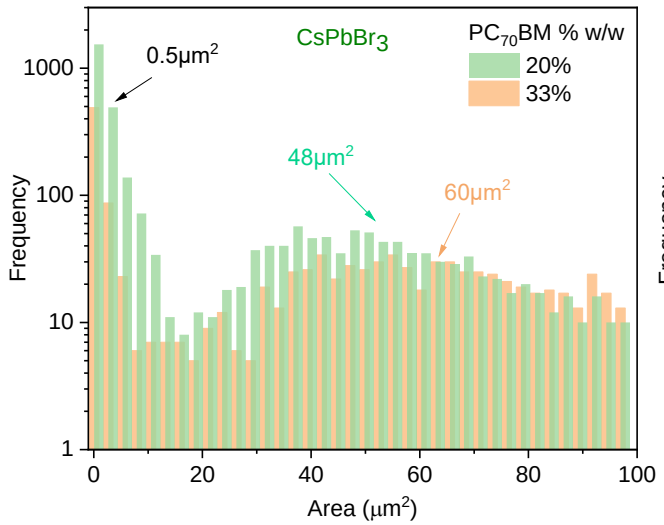
(b)$PC_{70}BM$ crystal structure

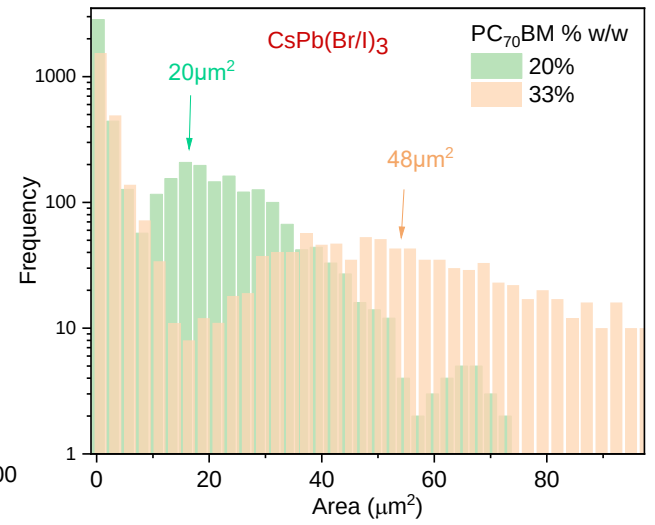
(c)Schematic illustration of thin film

- $CsPbBr_3$ & $CsPb(Br/I)_3$ NCs capped with octylamine/octanoic acid ligands fabricated via precipitation technique in ambient conditions [5]
- Fabrication of lateral devices using ITO and Au interdigital substrates
- Bended structures of NCs with $PC_{70}BM$ were deposited via spin coating followed by an EtAc washing step [1,4]

Optical & Fluorescence Microscopy

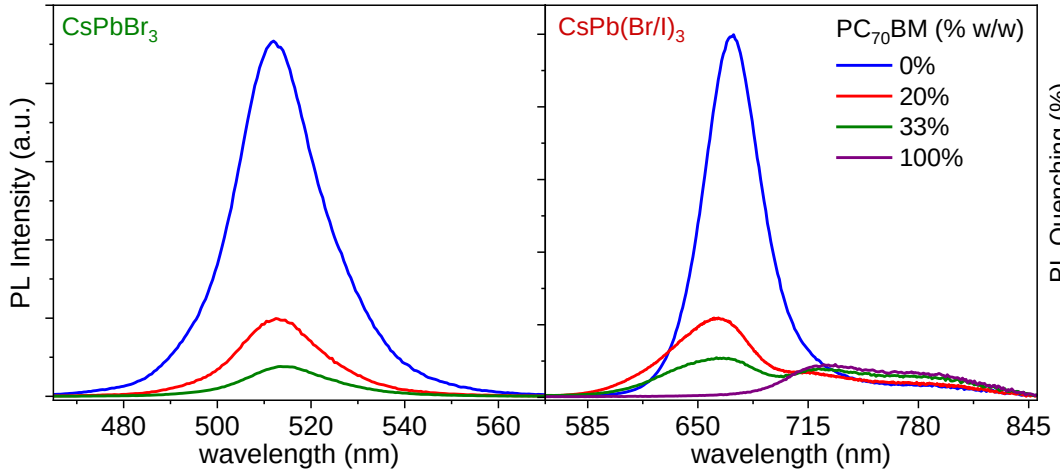


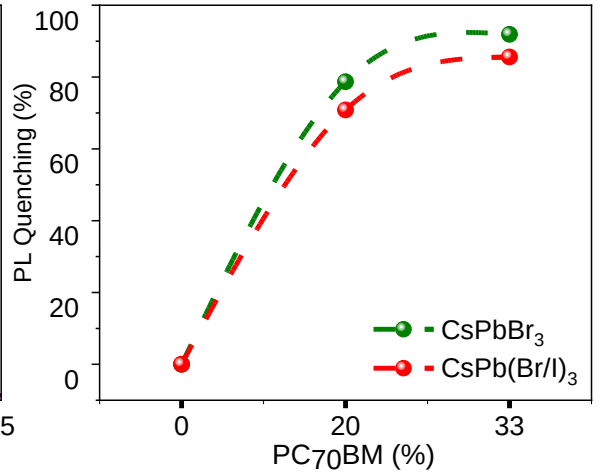




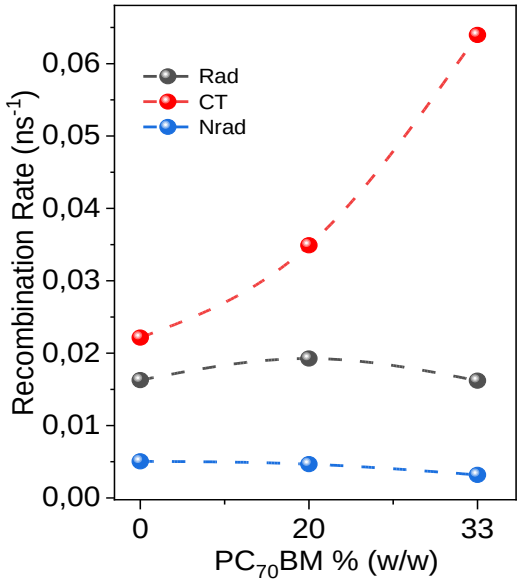
- Black dots denote $PC_{70}BM$ aggregates
- Increase of the fullerene content in the blends results in larger fullerene clusters and more disordered films.

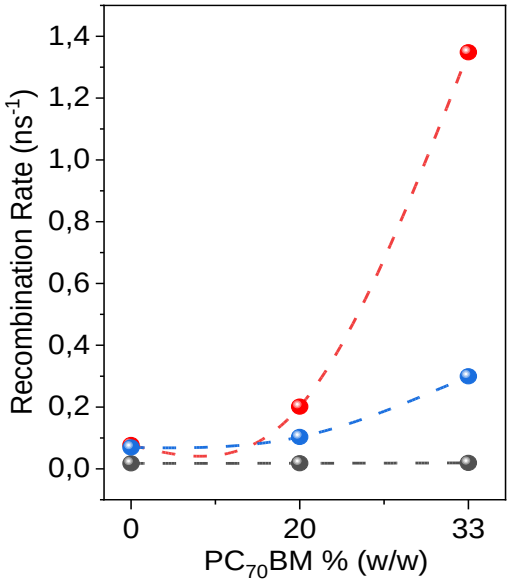
Optical properties





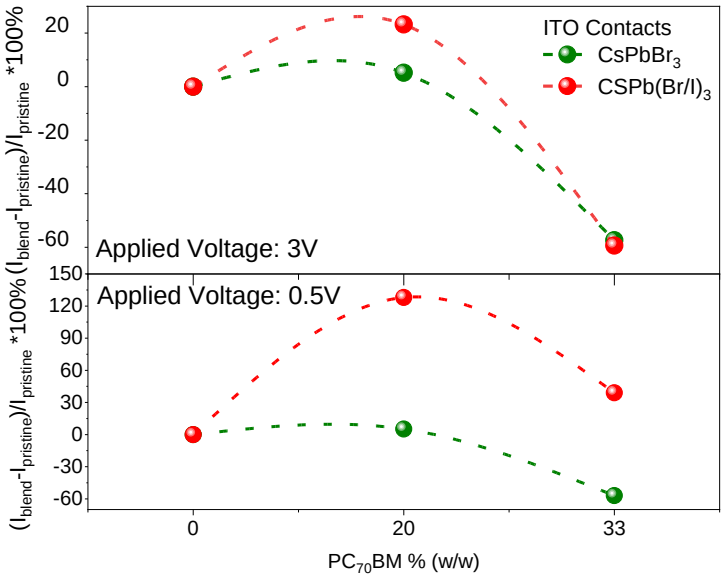
- Efficient quenching of NC emission upon $PC_{70}BM$ addition in both NC systems
- Quenching increases with the content of $PC_{70}BM$
- Indication of efficient exciton dissociation at the NCs/$PC_{70}BM$ interfaces

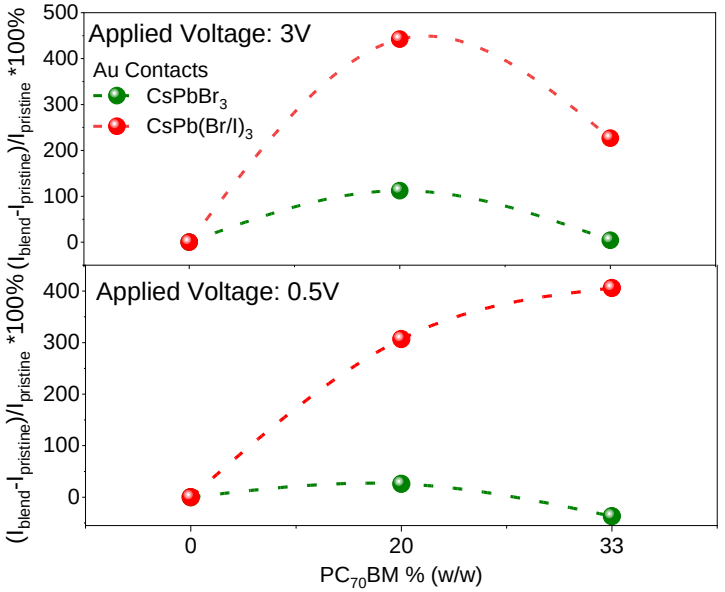




- PL lifetime quenches as $PC_{70}BM$ is added in agreement with steady-state PL.
- Higher lifetime quenching in red $CsPb(Br/I)_3$ NCs: More efficient exciton dissociation or enhanced exciton quenching at the heterointerface
- Recombination channels distinguished depending on time and rate fitting parameters to i) radiative, ii) non-radiative and iii) charge transfer recombination processes [6]

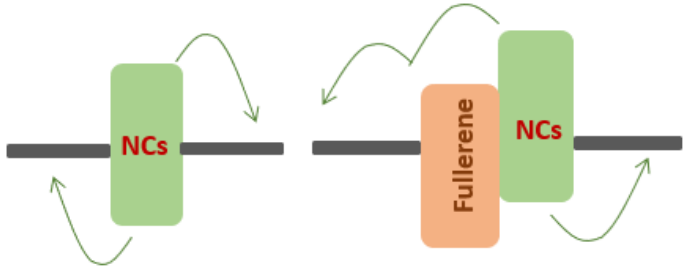
Photoconductivity





❖ ITO-based devices:

- Marginal improvement of 128%/ ~25% for bias of 0.5/3 V for $CsPb(Br/I)_3$ NCs
- Photocurrent increases by 5%/ ~5% for bias of 0.5/3 V for $CsPbBr_3$ NCs
- ITO-based devices produce mainly hole photo-current which is not influenced by the electron cascade probed by fullerene acceptor
- Fullerene acts like a hole blocking layer due to ITO and $PC_{70}BM$ energy levels



❖ Au-based devices:

- Significant improvement by 4.5 / 3 orders of magnitude for bias of 0.5/3 V for $CsPb(Br/I)_3$ NCs
- Photocurrent enhancement of 112%/ ~26% for bias of 0.5/3 V for $CsPbBr_3$ NCs
- $PC_{70}BM$ acts as an efficient bridge for electron transport and collection

References:

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Research Promotion Foundation

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