NTU India Connect Programme (Batch-2)
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Project Title: ***LEDs based on Caesium Lead Bromide Perovskite Nanocrystals***
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Project Guide: ***Alasdair A. M. Brown***

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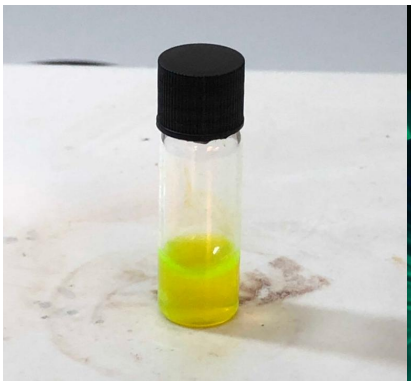
The following is a brief bulleted overview of the project work done from 8th May 2019 to 12th July 2019 at NTU ERI@N.

Lab Safety & Equipment Training:

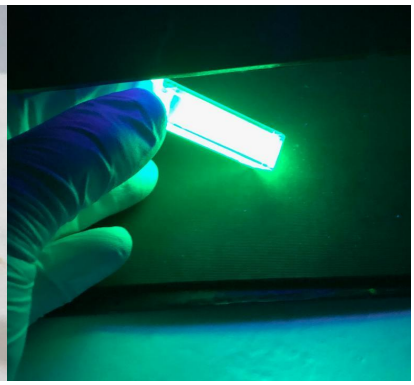
- General Lab Safety training was conducted before getting access to the cleanrooms.
- UV-Visible spectroscopy, photoluminescence spectroscopy and & photoluminescence quantum yield measurement trainings were conducted as they were to be used extensively throughout the project.
- Thermal evaporator and spin coater were used for fabricating the LEDs.

Nanocrystal (NC) Prep:

- Optimised a room temperature synthesis route for caesium lead halide perovskite nanocrystal.
- Post synthetic purification of NCs was performed by washing off excess ligands and synthetic by-products with polar solvents
- It is important to purify the NCs before using them in devices as otherwise the presence of excess aliphatic ligands can lower device performance by increasing resistivity.
- Usually multiple washes are done for complete purification and consequently, better efficiency.
- Centrifugation time and speed were optimised to obtain the narrowest particle size distribution.
- Rubidium doping was successfully achieved by substituting a small quantity of caesium precursor for the rubidium equivalent.



Synthesized NCs

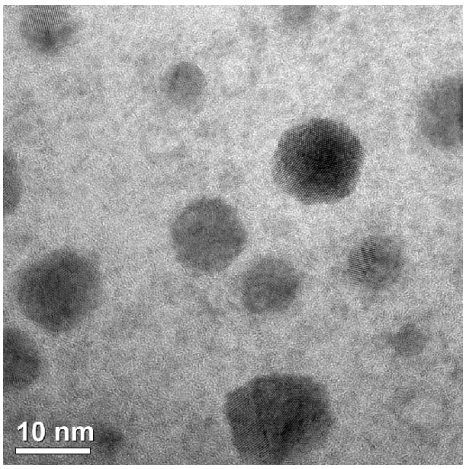


Synthesized NCs under UV lamp

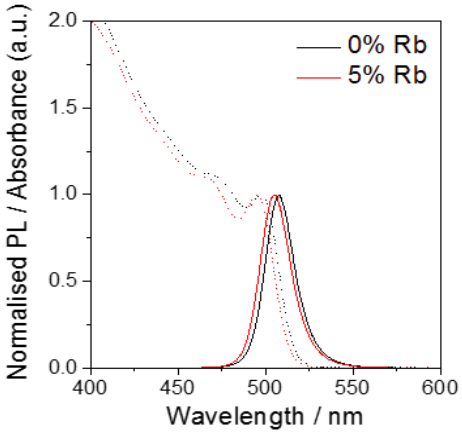
Characterisation of NCs:

- UV-Visible spectroscopy, photoluminescence spectroscopy and & photoluminescence quantum yield measurements were done on the synthesised NC inks.
- The synthesised green NCs consistently showed UV absorption edge and PL peaks at around 500 nm and 510 nm respectively.
- The reaction parameters such as ratio of ligands and reaction time were optimised to get very high (>95%) PLQY values.
- TEM imaging was also done to determine the shape, size and distribution of the synthesised

NCs.*



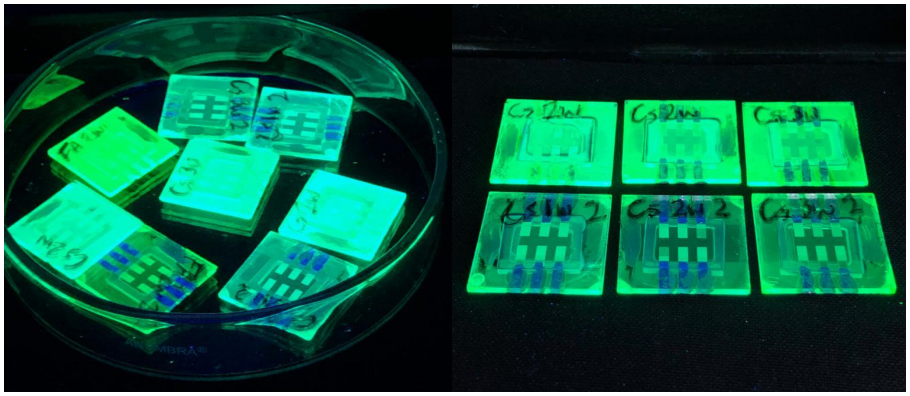
A TEM image of the synthesized NCs



UV-PL combined plots for undoped and Rubidium doped NCs

LED fabrication:

- Pre-etched ITO glass substrates were washed under sonication in detergent solution. Subsequent washes with solvents such as acetone and isopropanol were also performed.
- Substrates were dried and treated under UV ozone.
- PEDOT:PSS was filtered with a PVDF filter and spin coated. Thermal annealing was done to remove excess solvent. Next poly-TPD layer was deposited.
- Then CsPbBr3 NC ink was dropped and spin coated.



LEDs fabricated from CsPbBr3 NCs under UV lamp

- Next POT2T, LiF and Al layers were deposited by thermal evaporation. Metal shadow mask was used for selected area deposition.

LED Characterisation:

- External Quantum Efficiency(EQE) and luminescence lifetime measurements were done on the fabricated LEDs.