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Synthesis of cesium lead halide perovskite nanoparticles for application in light-emitting electrochemical cells (LECs)

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Since pioneering work of Kovalenko's team in 2015¹, lead halide perovskite (LHP) nanoparticles have been the subject of an extremely large number of publications due to their emission wavelength tunability with a narrow band and a quantum yield up to 99%.² These features make LHP nanoparticles promising materials for elaboration of opto-electronic devices.³ Among them, light-emitting electrochemical cells (LEC) possess a great potential for applications due to a simpler architecture compared to organic light-emitting diode (OLEDs). In LEC, the active layer consists only in an emitting material mixed with an electrolyte and an ionic conductive polymer, sandwiched between two metallic electrodes without the need of specific electron- and hole-transporting layers.⁴ When a bias is applied, ions and counter-ions migrate from the electrolyte to the electrodes creating 3 layers: n doped region, p doped region and the junction region.⁵ It allows injected charges (holes and electrons) to move through the device and recombine to produce light emission (Figure 1.a). In this work, 10 to 15 nm-sized CsPbX₃ LHP nanoparticles (X= Cl, Cl/Br, Br, Br/I or I) (Figure 1.b) are synthesized under air at room temperature, following a triple-ligand synthesis method,⁶ as emitting materials to reach blue, green, and red luminescence (Figure 1.c). The present study includes the synthesis strategy, the optimization of parameters such as emission wavelength and phase stability vs. ligand ratio as well as morphological and optical characterizations. Furthermore, latest progress in a LEC device elaboration and characterization made of CsPbBr₃ nanoperovskites mixed with polyethylene oxide (PEO) as ionic conductive polymer and lithium triflate as electrolyte, will also be discussed.

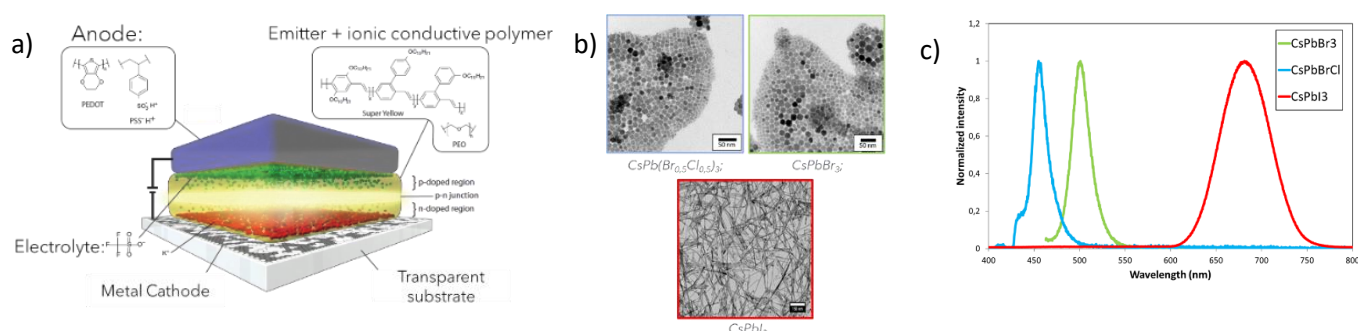


Figure 1. Light-emitting electrochemical cell and cesium lead halide perovskite nanoparticles, a) targeted light-emitting electrochemical cell architecture with graphene electrodes and perovskite nanoparticles as emitter. b) TEM images of CsPbX₃ nanoparticles and c) luminescence spectra of corresponding CsPbX₃ solutions (excitation 405 nm) in function of halide composition

- (1) Protesescu, L.; Yakunin, S.; Bodnarchuk, M. I.; Krieg, F.; Caputo, R.; Hendon, C. H.; Yang, R. X.; Walsh, A.; Kovalenko, M. V. *Nano Lett.* **2015**, *15* (6), 3692–3696. <https://doi.org/10.1021/nl5048779>.
- (2) Liu, F.; Zhang, Y.; Ding, C.; Kobayashi, S.; Izuishi, T.; Nakazawa, N.; Toyoda, T.; Ohta, T.; Hayase, S.; Minemoto, T.; Yoshino, K.; Dai, S.; Shen, Q. *ACS Nano* **2017**, *11* (10), 10373–10383. <https://doi.org/10.1021/acsnano.7b05442>.
- (3) Wehrenfennig, C.; Eperon, G. E.; Johnston, M. B.; Snaith, H. J.; Herz, L. M. *Advanced Materials* **2014**, *26* (10), 1584–1589. <https://doi.org/10.1002/adma.201305172>.
- (4) Nannen, E.; Frohleiks, J.; Gellner, S. *Advanced Functional Materials* **2020**, *30* (33), 1907349. <https://doi.org/10.1002/adfm.201907349>.
- (5) Pei, Q.; Yang, Y.; Yu, G.; Zhang, C.; Heeger, A. J. *P. J. Am. Chem. Soc.* **1996**, *118* (16), 3922–3929. <https://doi.org/10.1021/ja953695q>.
- (6) Liu, Y.; Tang, S.; Fan, J.; Gracia-Espino, E.; Yang, J.; Liu, X.; Kera, S.; Fahlman, M.; Larsen, C.; Wågberg, T.; Edman, L.; Wang, J. *ACS Appl. Nano Mater.* **2021**, *4* (2), 1162–1174. <https://doi.org/10.1021/acsanm.0c02797>.