# Organo-metal Halide (OMH) Perovskite Quantum Dots (PQDs): Surface Chemistry Approach to Enhancing Stability and Optical Properties

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Organo-metal halide (OMH) perovskites have shown great promise for various applications including photovoltaic solar cells and light emitting diodes due to their unique optical and electronic properties. However, device and material degradations caused by factors such as light, oxygen, water, temperature, and oxide layers used in devices present a major challenge for practical applications. We use OMH perovskite quantum dots (PQDs) as a good model system to understand the origin of the material instability and to develop strategies to enhance stability using surface passivation with special molecular ligands to reduce surface defects or trap states. Specifically, we have synthesized methylammonium ($MA^+$) lead halide, $CH_3NH_3PbX_nY_{3-n}$, PQDs with tunable optical properties by controlling their size and compositions (X and Y=Cl, Br, I; n=0, 1, 2). We also developed and evaluated several strategies to passivate surface states including the use of cone-shaped ligands.[1] The structural and optical properties of the PQDs have been characterized using a combination of spectroscopy and microscopy techniques. Furthermore, exciton dynamics of the PQDs have been investigated using ultrafast laser techniques to gain deep fundamental insight into their relation to surface properties.[2] One important finding is that ammonium ions ($-NH_3^+$) and carboxylate groups ($-COO^-$) have synergistic effects on surface passivation, attributed to simultaneous passivation of both anions ($X^-$) and cations ($Pb^{2+}$ or $MA^+$) on the surface. As further support to this finding, we have demonstrated that bifunctional peptides can serve as bidentate ligands for effective surface passivation in a manner that is simple to implement.[3] These studies demonstrate that surface chemistry approaches are highly promising for stabilizing OMH perovskites.

1. B. Luo, *et al.*, *Angewandte Chemie Int. Ed.*, **2016**, *55*, 8864.
2. B, Luo, *et al.*, *J. Phys. Chem. C*, **2015**, *119*, 26672.
3. B, Luo, *et al.*, *Adv. Functional Mater.,* **2016**, in press.