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Photophysics of 3D and 2D Halide Perovskites

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Halide perovskites (HP) are a very promising new class of semiconductors with attractive properties for the conversion of solar energy and other optoelectronics applications such as laser, LED or photodetectors. In particular, layered 2D hybrid halide perovskites have attracted a lot of attention due to their superior stability compared to their 3D counterpart and their intriguing excitonic properties. A deeper understanding of the physical properties of the material is still required to optimize further the performance of devices. 2D layered halide perovskites have the general formula $(\text{RNH}_3)_2(\text{MA})_{n-1}\text{A}_n\text{X}_{3n+1}$ where MA = CH_3NH_3 and R is an alkyl or aromatic group, M a metal, and X a halide (Figure 1). Their electronic structure is comparable to a multi-quantum well structure, with n perovskite layers separated by large organic cations. Unlike 3D HP, they possess a huge exciton binding energy due to quantum and dielectric confinement and stable excitonic emission at room temperature.[1,2] The optical properties can be tailored with the number of layers and the choice of the organic cation.[3,4]

We have investigated the optical properties of 2D and 3D hybrid perovskites using a combination of photoluminescence (PL) spectroscopy and time-resolved PL, at room and cryogenic temperature and under magnetic field. First, we will describe the recombination dynamics, the influence of trap states and phonons on the emission properties of 2D halide perovskites. Second, we will discuss the nature of defects in 3D HP based on the detailed study of their emission at low temperature.

[1] H. Diab *et al.* J. Phys. Chem. Lett. 75093–5100 (2016)

[2] G. Delpoirt *et al.* J. Phys. Chem. Lett. 10(17), 5153–5159 (2019)

[3] J. M. Urban *et al.*, J. Phys. Chem. Lett. **11**(15), 5830–5835 (2020)

[4] F. Lédée *et al.*, *Materials Horizons*. 10.1039/d0mh01904f (2021)

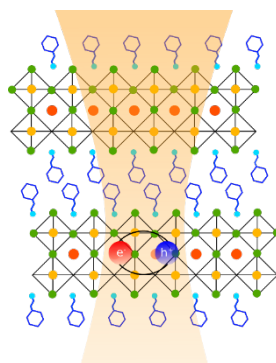


Figure 1: Schematic representation of the photogeneration of excitons in a 2D halide perovskite, formed of inorganic layers (PbI₆ octahedra) and large organic molecule (phenylethylammonium, in blue)