Aggregation-induced emission in lamellar solids of colloidal perovskite quantum wells

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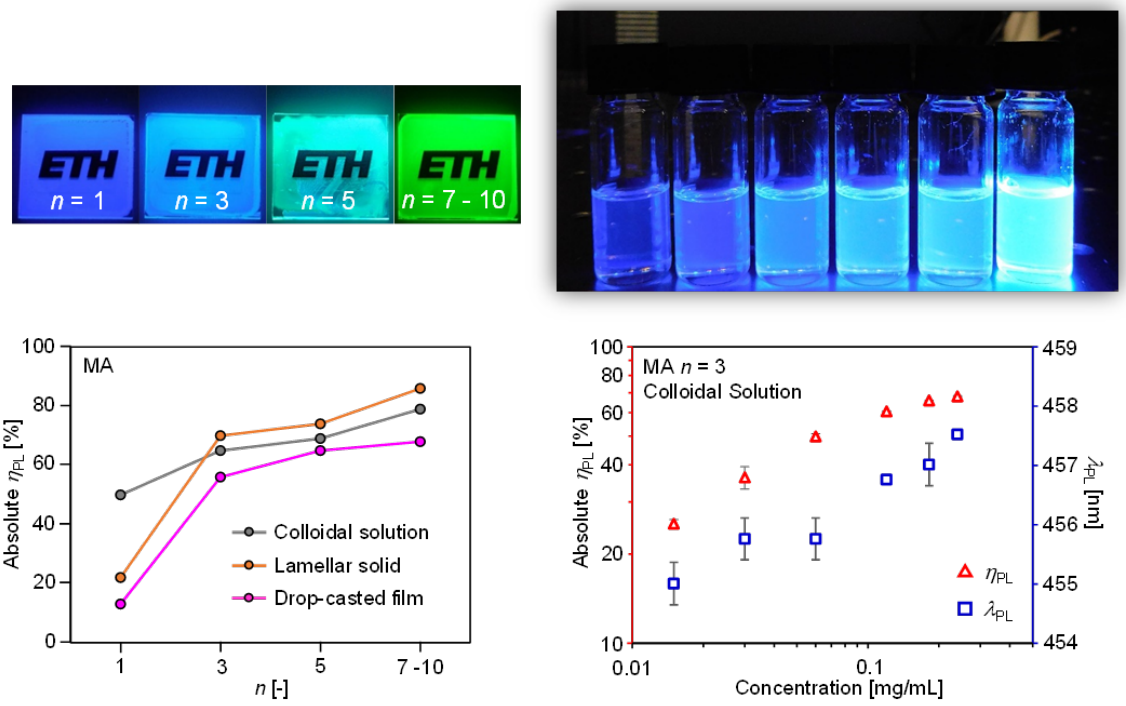
The outstanding excitonic properties, including photoluminescence quantum yield (η_{PL}), of individual, quantum-confined semiconductor nanoparticles are often significantly quenched upon aggregation, representing the main obstacle toward scalable photonic devices. We report aggregation-induced emission phenomena in lamellar solids containing layer-controlled colloidal quantum wells (QWs) of hybrid organic-inorganic lead bromide perovskites, resulting in anomalously high solid-state η_{PL} of up to 94%. Upon forming the QW solids, we observe an inverse correlation between exciton lifetime and η_{PL}, distinct from that in typical quantum dot solid systems. Our multiscale theoretical analysis reveals that, in a lamellar solid, the collective motion of the surface organic cations is more restricted to orient along the [100] direction, thereby inducing a more direct bandgap that facilitates radiative recombination. Using the QW solids, we demonstrate ultrapure green emission by completely downconverting a blue gallium nitride light-emitting diode at room temperature, with a luminous efficacy higher than 90 lumen W^{-1} at 5000 cd m^{-2}, which has never been reached in any nanomaterial assemblies by far [1].



[1] J. Jagielski *et al.*, *Sci. Adv.*, **2017**, 3, eaaq0208.