ORAL DEFENCE ANNOUNCEMENT

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Photo-physics of Light Amplification in Lead Halide Perovskites

Low temperature solution-processed Organic-Inorganic Hybrid lead-halide Perovskites (OIHPs) nanocrystals (NCs) are new and emerging class of semiconducting materials that possesses high quantum yields (PLQY), large linear and non-linear absorption cross-sections, tunable emission wavelength via facile halide substitutions/exchanges. These properties make OIHP NCs the ideal candidate for light-emitting applications such as LEDs and lasing. Although preliminary reports showed a consistent trend of low (sub \( \mu \text{Jcm}^{-2} \)) ASE and lasing thresholds, these NC ensembles suffer from ambient air and moisture attacks, causing degradation and inevitably imposes stringent storage and operation conditions. Furthermore, the main fundamental photo-physics behind its optical gain is still not well understood. Therefore, in this thesis, we focus on (I) proposing a synthetic treatment during the Ligand-Assisted RePrecipitation (LARP) of Methyl Ammonium Lead Bromide (CH\(_3\)NH\(_3\)PbBr\(_3\)) NCs in order to improve its surface passivation, (II) using Photoluminescence (PL) and Time-Resolved Photoluminescence (TR-PL) spectroscopy to characterize its ASE/lasing properties and (III) elucidating its carrier dynamics leading to population inversion and subsequently light amplification via spin-dependent Pump-Probe techniques. Specifically, we show that the bound excitons (BX) in CH\(_3\)NH\(_3\)PbBr\(_3\) NCs play a crucial role in the formation of zero-spin biexcitons (XX) with low biexciton binding energies (EBXX ~ 20meV), which are responsible for intrinsically spin-unpolarized optical gain mechanisms.

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