Optical Gain in Core-only CdSe and Core/Crown CdSe/CdS 3.5 monolayer Nanoplatelets.

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CdSe nanoplatelets emitting in the blue region of the visible spectrum are promising candidates for light-amplification and light-emitting diode applications. For this reason, recently an improved synthesis protocol for 3.5 monolayer CdSe NPLs was put forward, leading to photoluminescence (PL) quantum yields up to 30%. [1] However, due to the high surface-to-volume ratio, blue emitting *core-only* nanoplatelets still suffer from charge trapping that results in intra-gap radiative emission from the defect states. As such, it remains an open question to which extent these defects affect their ultrafast properties as well, including the development of net stimulated emission. Here, we first show that optimized 3.5 ML CdSe nanoplatelets show optical gain between 480-520 nm due to stimulated emission along the biexciton-to-exciton transition.[2] Next, we compare the gain characteristic of core-only CdSe with core/crown CdSe/CdS 3.5 ML NPLs of increasing crown volume. The crown procedure results in both a faster exciton radiative recombination rate and an improvement of the PL quantum yield up to 60%. Our results show that crowned samples exhibit overall a lower gain threshold with compared to core-only CdSe nanoplatelets. On the other hand, we observe comparable gain lifetime regardless of the crowning procedure due to residual ultrafast charge trapping not alleviated by the crown growth. Our results pave the way towards accurate design of ultra-thin quasi two-dimensional systems for blue spectrum light amplifiers and lasers based on.

[1] Di Giacomo, A.; Rodà, C.; Khan, A. H.; Moreels, I. Colloidal Synthesis of Laterally Confined Blue-Emitting 3.5 Monolayer CdSe Nanoplatelets. Chem. Mater. 2020, 32, 9260-9267.
[2] Geiregat, P.; Tomar, R.; Chen, K.; Singh, S.; Hodgkiss, J. M.; Hens, Z. Thermodynamic Equilibrium between Excitons and Excitonic Molecules Dictates Optical Gain in Colloidal CdSe Quantum Wells. J. Phys. Chem. Lett 2019, 10, 3637-3644.