

THE PHYSICS COLLOQUIUM

Thursday, 22 September 2022, 4:00 p.m.
Nijenborgh 4, Schröderzaal 5115.0317

Excited State Dynamics for Light Emission and Lasing in Quasi-2D and 3D Perovskites

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Perovskites are of interest for light emission and lasing. Considering optical pumping, the dynamics of the excited-state populations created after optical excitation dictate the material's performance. As perovskites move from a 3D structure into a mixture of 2D quantum wells with differing thicknesses (quasi-2D perovskites) the nature of the excited-state species significantly change, as does their performance as a gain material.

In this talk I will present our recent work on understanding how the emission shifts from being based on free carrier recombination to excitonic recombination as the average quantum well thickness decreases in quasi-2D structures, and the effect that this has on limiting gain performance. It will be shown that free carrier recombination is actually more attractive for perovskite gain materials, and that conversion of a quasi-2D precursor film is an effective way of creating high performance CsPbBr₃. Energy funnelling will be discussed in the quasi-2D materials, and also in newly introduced quasi-2D / 3D laminated heterostructures.

Finally, I will briefly discuss ongoing work examining the effect of electrical bias on optical gain thresholds.

References:

- (1) Li, Y.; Roger, J.; Allegro, I.; Fischer, J. C.; Jin, Q.; Lemmer, U.; Howard, I. A.; Paetzold, U. W. Lasing from Laminated Quasi-2D/3D Perovskite Planar Heterostructures. *Advanced Functional Materials* 2022, 2200772.
- (2) Kaiser, M.; Li, Y.; Gharibzadeh, S.; Richards, B. S.; Paetzold, U. W.; Howard, I. A. Charge Carrier and Exciton Dynamics in Perovskites Revealed by Time-Integrated Photoluminescence after Double-Pulse Excitation. *Advanced Materials Technologies* 2022, 2200152.
- (3) Li, Y.; Allegro, I.; Kaiser, M.; Malla, A. J.; Richards, B. S.; Lemmer, U.; Paetzold, U. W.; Howard, I. A. Exciton versus free carrier emission: Implications for photoluminescence efficiency and amplified spontaneous emission thresholds in quasi-2D and 3D perovskites. *Materials Today* 2021, 49, 35-47.
- (4) Kaiser, M.; Li, Y.; Allegro, I.; Richards, B. S.; Paetzold, U. W.; Howard, I. A. Interpreting the Time-Resolved Photoluminescence of Quasi-2D Perovskites. *Advanced Materials Interfaces* 2021, 8 (24), 2101326.
- (5) Allegro, I.; Li, Y.; Richards, B. S.; Paetzold, U. W.; Lemmer, U.; Howard, I. A. Bimolecular and Auger Recombination in Phase-Stable Perovskite Thin Films from Cryogenic to Room Temperature and Their Effect on the Amplified Spontaneous Emission Threshold. *The Journal of Physical Chemistry Letters* 2021, 12 (9), 2293-2298.

Join us for coffee starting 3:30 p.m. Refreshments will be served after the lecture.

For more information contact the host: Jan Anton Koster (l.j.a.koster@rug.nl)

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