Canadian Association of Physicists
Association canadienne des physiciens et physiciennes

Contribution ID: **2212** Type: **Oral (Graduate Student) / Orale (Étudiant(e) du 2e ou 3e cycle)**

Four-wave mixing studies of carrier dynamics in CH3NH3PbI3 organic-inorganic Perovsite (G)

Monday 11 June 2018 14:45 (15 minutes)

Solar cells based on CH3NH3PbI3 (MAPI) have reached efficiencies comparable to the best polycrystalline silicon solar cells in just 9 short years [1]. Despite the unparalleled increase in efficiency, the fundamental photo physical properties in this archetypical perovskite material system are not yet well understood. In order to further optimize device performance, it is essential to determine the fundamental processes that govern carrier generation, and transport. Here we have utilized four-wave mixing spectroscopy to study the optical response of MAPI thin films with excitation densities comparable to solar cell operating conditions, revealing weaker carrier-carrier and exciton-carrier scattering in the perovskite system compared to GaAs [2], exciton binding energies for bound and unbound excitons in the low temperature phase [3], and a measurement of the carrier diffusion length at room temperature by implementing the transient grating four-wave mixing technique [4].

References

[1] http://www.nrel.gov./ncpv/images/efficiency_chart.jpg.
[2] S. A. March, C. Clegg, D. B. Riley, D. Webber„ I. G. Hill, and K. C. Hall, Simultaneous observation offree and defect-bound excitons in CH3NH3PbI3 using four-wave mixing spectroscopy, Scientific Reports 6, 39139 (2016)
[3] S. A. March, DB Riley, C Clegg, D Webber, X Liu, M Dobrowolska, Jacek K Furdyna, Ian G Hill, Kimberley C Hall, Four-wave mixing in perovskite photovoltaic materials reveals long dephasing times and weaker many-body interactions than GaAs, ACS Photonics 4 (6), 1515-1521 (2017)
[4] D. Webber, C. Clegg, A. W. Mason, S. A. March, I. G. Hill, K. C. Hall, Carrier diffusion in thin-film CH3NH3PbI3 perovskite measured using four-wave mixing, Applied Physics Letters 111 (12), 121905 (2017)

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Session Classification: M2-1 Ultrafast EM Waves II: THz Science (DAMOPC/DCMMP) | Ondes EM ultrarapides II: Science des THz

Track Classification: Condensed Matter and Materials Physics / Physique de la matière condensée et matériaux (DCMMP-DPMCM)