LABORATOIRE INTERACTIONS, DYNAMIQUES ET LASERS

LIDYL-ERL 9000
CEA, CNRS, Université Paris-Saclay

THESE LIDYL

Carolina VILLAMIL FRANCO
Groupe DICO

Le Mercredi 30 Septembre 2020 à 14H00
Amphi Talairach, Neurospin, Bât. 145, CEA Saclay (limited number of people)
or visio: https://eu.bbcollab.com/guest/482c4253d3ee4c7895dd20eb64572aa4

"Ultrafast dynamics of excitons and charge carriers in colloidal perovskite nanostructures studied by time-resolved optical spectroscopies "

Halide perovskites have emerged as very promising photoactive materials due to their outstanding optoelectronic properties combined with low-cost processability. In spite of their successful implementation in photovoltaic or light-emitting devices, a better understanding of the photo-induced relaxation and recombination dynamics is needed in order to enhance the device performances. To this end, time-resolved photoluminescence and femtosecond transient absorption spectroscopy were used to investigate the effects of confinement and composition in different lead iodide perovskite nanostructures.

For the investigation of the hot exciton/charge carrier dynamics ("cooling"), a global analysis method was used, where the temporal evolution of the spectral lineshapes was modeled with a sequential kinetic scheme. This method was successfully applied to effectively describe the continuous energy relaxation in weakly-confined nanoplates and allowed disentangling the *hot phonon bottleneck* from the *Auger reheating* effects at high excitation fluence. The global analysis was also applied to the cooling dynamics in strongly-confined 2D nanoplatelets. As in the weakly-confined samples, the NPL cooling rate decreases with the excitation fluence. However, it remains ultrafast, evidencing the absence of an *intrinsic phonon bottleneck*. This leads us to propose a ligand-mediated relaxation pathway that participates to the ultrafast hot exciton cooling in 2D NPLs in the strong confinement regime.

In addition, multiple exciton recombination dominated by non-radiative Auger recombination (AR) was studied in the strongly-confined 2D perovskite NPLs. At moderate fluence, the AR is *diffusion-limited* and thus highly depends on the initial inter-exciton distance and sample dimensionality. Typical AR occurs then on a timescale of several hundreds of picoseconds. In contrast, high excitation fluences produce "overlapping" excitons with AR times of less than 10 ps (intrinsic, *reaction-limited* AR).

Finally, the exciton population dynamics of 2D NPLs were studied after excitation in the ultraviolet. The strong dependence of the AR with the inter-exciton distance allows the identification of *multiple exciton generation* (MEG), which involves the reaction of "geminate", spatially close biexcitons, produced by the absorption of a single high-energy photon.

Formalités d'entrée :
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Sans autorisation, vous ne pourrez entrer sur le Centre de Saclay. Tél. : 33.1.69.08.74 09- Fax : 33. 1.69.08.76.39 - email : caroline.lebe@cea.fr ou veronique.gereczy@cea.fr
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