Title: Carrier multiplication and hot electron transfer in semiconductor nanocrystals for 3rd generation solar cells

Abstract:
Colloidal semiconductor nanocrystals show promise for a range of applications due to their size tunable absorption and emission properties. Current applications include using them as superior down conversion phosphors for displays and lighting, while more advanced (future) applications would be to use them as lasers, photodetectors, solar cells and light emitting diodes.

A particularly interesting aspect is the observation of efficient Carrier Multiplication (CM) in lead chalcogenide nanocrystals, which may be exploited in third generation photovoltaic devices. We have studied CM in dispersion and films of QDs using a combination of transient absorption spectroscopy, time-domain THz spectroscopy and time-resolved microwave conductivity measurements. Our recent experiments reveal that the specific band structure of lead chalcogenides semiconductors is responsible for the efficient CM that is commonly observed.[1] This band structure is in principle a property of the bulk material, but it can be tuned due to quantum confinement in nanostructures.

Finally I will discuss the observation of hot electron transfer between different types of quantum dots[2]. Similar to CM, hot carrier solar cells are often mentioned as a means to achieve high efficiencies in solar cells. We demonstrate fast and efficient hot-electron transfer between PbSe and CdSe quantum dots assembled in a quantum-dot heterojunction solid. The efficiency of the transfer process increases with excitation energy as a result of the more favorable competition between hot-electron transfer and electron cooling. The experimental picture is supported by time-domain density functional theory (TDDDFT) calculations, showing that electron density is transferred from PbSe to CdSe quantum dots on the sub-picosecond timescale.

1. Spoor, F. C. M. et al., Asymmetric Optical Transitions Determine the Onset of Carrier Multiplication in Lead Chalcogenide Quantum Confined and Bulk Crystals. *ACS Nano* **2018**, **DOI:** 10.1021/acsnano.8b01530

2. Grimaldi, G.. et al., A. Hot-electron transfer in quantum-dot heterojunction films. *Nat. Commun.* **2018,** *accepted for publication*.

Short Biography
Arjan Houtepen obtained his PhD Cum Laude under supervision of prof. Vanmaekelbergh at Utrecht University and subsequently became tenure track assistant professor in Delft. In 2009/2010 he was a visiting scientist in the group of prof. Feldmann in Munich. At present he is Associate Professor at the Chemical Engineering department at Delft University and guest professor in the Physics and Chemistry of Nanostructures group at Ghent University. Since 2017 he is a member of the Young Academy of the Royal Academy of Sciences.