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# CdSe/CdS quantum rods: Highly luminescent nanocrystals with temperature-independent lasing threshold and enhanced two-photon absorption

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## Abstract

Colloidal CdSe/CdS quantum rods (Qrods) are a versatile nanomaterial. By growing a CdS rod-like shell around a spherical CdSe core, surface defect formation can be efficiently suppressed, yielding a high photoluminescence quantum efficiency routinely larger than 50%. Furthermore, the small valence band offset between CdSe and CdS allows further control over their optical properties due to electron delocalization into the shell, which modifies the electron-hole wave function overlap and hence the luminescence spectrum and decay rate.

The stimulated emission (SE) of these nanocrystals can also be controlled in great detail. SE can be obtained from CdS band-edge states, CdSe core states, or even both simultaneously, by control the carrier dynamics with the core diameter and the rod length. Moreover, temperature-dependent measurements from 325K down to 5K have revealed that the discrete nature of the electronic states leads to a nearly constant SE threshold, paving the way for temperature-insensitive quantum dot lasers.

A large CdS rod encompassing the CdSe core is also beneficial for enhancing the two-photon absorption (2PA). Investigating the 2PA spectrum in CdSe/CdS Qrods, we observed a strong blue shift of the 2PA transitions compared to the linear absorption (1PA) spectrum. Results are quantitatively explained by *k.p* calculations, which attribute the blue shift to different optical selection rules applying to 1PA and 2PA. Combining these data with the Qrod SE results, we could demonstrate low-threshold gain by pumping under the appropriate two-photon conditions.

## Biography

Iwan Moreels obtained his Ph.D. degree in applied physics at Ghent University (Belgium) in April 2009. His work consisted of the synthesis, processing and application of near-infrared PbS and PbSe colloidal quantum dots on a silicon photonics platform. Ph.D. studies were followed by post-doctoral research in optical spectroscopy at Ghent University and the IBM Zurich research lab (Switzerland). In Januari 2012 he joined the Istituto Italiano di Tecnologia (Italy), where he now is leading the Nanophotonics Lab. He has published 35 papers in peer-reviewed journals, including 2 review articles.