Performance and Stability of Quantum Dot-based Luminescent Solar Concentrator

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Luminescent solar concentrators (LSCs) consist of transparent thin sheets in which luminescent species (luminophores) are dispersed. The luminophores absorb sunlight and reemit the energy as down-shifted photons that are partially trapped by total internal reflection and waveguided to the edges where they are absorbed by solar cells. LSCs are promising building integrated photovoltaic elements since they offer the prospect of adding energy-harvesting functionality to windows and façades, thus addressing the need to generate sustainable energy in urban environments. Their deployment has however been hindered by the lack of suitable luminophores. Colloidal semiconductor nanocrystals (quantum dots, QDs) are promising luminophores for LSCs, due to their very broad absorption spectra, large absorption cross-sections, narrow emission spectra, potentially high photoluminescence quantum yields and solution processability. In this talk, I will discuss the results of a long-term (2-year) outdoor test comparing the performance of three different large-area QD-based LSCs (CdSe/CdS/ZnS, InP/ZnSe/ZnS and CuInS2/ZnS QDs) [1,2]. An organic dye (Lumogen) -based LSC and a blank device with no luminophore were used as references. Our results show that the efficiency changes in the QD-based LSCs are related to an interplay between photodarkening and photobrightening processes in the QDs, which may be ascribed to, respectively, the creation and annihilation of traps for the photogenerated carriers. These results are relevant not only to LSCs but also to any application involving photoinduced processes in QDs.

References:

[1] T.A. de Bruin, R. Terricabres-Polo, A. Kaul et al., C. de Mello Donega, W.G.J.H.M. van Sark, Solar RRL 7 (2023) 2201121.
[2] R. Terricabres-Polo, T.A. de Bruin, A. Kaul, W.G.J.H.M. van Sark, C. de Mello Donega, in preparation.