Luminescent solar concentrators based on quantum dot luminophores

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Deployment of photovoltaics (PV) in the urban environment is usually done by installing PV modules on rooftops. Making PV components an integral part of the building envelope is growing fast and is referred to as Building Integrated Photovoltaics (BIPV). BIPV solutions exist in opaque and transparent form, and both are designed to be part of building facades. The latter solution requires optimization of transparency in relation to efficiency as the PV-window has two functions. While transparent organic and amorphous silicon PV already is used, the Luminescent Solar Concentrator (LSC) in combination with side-mounted solar cells has been identified as a promising solution due to its ability to absorb only certain wavelengths allowing for tuning the apparent window color and transparency, and its low costs. The LSC has been a topic of research since the mid 1970s. In the past decade, alternative luminophores used in the LSC have been developed that are tunable and more stable than organic dyes, i.e., semiconductor quantum dots/rods, or, more generally, nanocrystals. LSC device efficiencies, however, are still low.

In this contribution, we will address the use of quantum dot luminophores for transparent PV solutions. As transparency and device efficiency cannot be optimized at the same time, we resort to ray-trace monte carlo simulations to find device efficiency for various types of quantum dots in relation to absorption properties. We will relate average visible transmission to device efficiency. Further, we will show simulation results on the effect of anisotropic emissions and close with results from a 1-year outdoor test of quantum dot based LSCs.