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Luminescent materials for enhanced silicon solar cell performance

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Lanthanide-based luminescent nano-materials have been extensively investigated due to their contribution to a different range of applications. The use of lanthanide ions for enhancing the solar cell efficiency has recently been reported. Silicon based solar cells show a poor response to UV–blue range of the solar spectrum. This limits the crystalline silicon (c-Si) solar cell efficiency to only 30%, according to detailed balance model developed by Shockley-Queisser. The thermalization of the charge carriers is one of the major loss mechanisms, which could be overcome by deposit a down-converting layer on top of the c-Si solar cell. This phenomenon has recently been reported in Pr3+—Yb3+ couple doped materials. Unfortunately, the weak absorption cross-section of the 4f-4f transition of Pr3+ ion preventing absorption of the larger part of the solar spectrum. For efficient down-conversion it is crucial that the major part of the high energy region of the solar spectrum is converted into two near-infrared photons. Therefore, a third sensitizer that can absorb efficiently all light in the UV-blue part of the solar spectrum and transfers the energy to the down-conversion couple, e.g. 3Pj levels of Pr3+ is required. Recent theory has predicted that by applying such down-conversion layer on top of the c-Si solar cell, the Shockley-Queisser limit could be raised up to 40%. This study reports on the application of rare-earth-doped inorganic materials for achieving external quantum efficiencies greater than unity and enhancing the conversion efficiency of silicon solar cells by using the down-conversion mechanism.

Summary

The luminescent materials can be used extensively in many applications. In this paper the use of luminescent materials based lanthanide ions in solar cell application will be discussed.

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