Europium complexes as promising downshifters for CIGS solar cells

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The down-shifting (DS) approach is one of *third*- or *next*-generation PV concepts to enhance solar cell conversion efficiency which consists in converting UV photons into visible or near infrared light. Now, two types of DS materials are in strong competition: organic dyes with approaching unity quantum yield (QY) and Eu(III) coordination complexes with QYs of 85 – 90 %. Advantageously, the latter has large Stokes' shifts without self-absorption and show $^5D_0 \rightarrow {}^7F_J$ (J = 0 - 6) narrow emission bands, whose $^5D_0 \rightarrow {}^7F_2$ transition reaches up to 80 – 85 % of all emission light and milliseconds photoluminescence lifetime. Additional advantages of Eu(III) complexes versus other DS materials are long term stability upon light irradiation and a higher thermal decomposition temperature.

The aim of this study consists to enhance the conversion efficiency of CIGS solar cells in UV region due to a luminescent DS layer based on Eu(III) compounds. Herein, we will show an improvement of the EQE at 360 nm up to 58 % compared to 14 % without DS layer (Figure 1) and an increase in the short-circuit current in the 300 – 420 nm region, by 0.56 mA/cm^2. In the best case a boost of the CIGS solar cell conversion efficiency by 0.8 % absolute is observed thanks to the DS layer.[1,2]

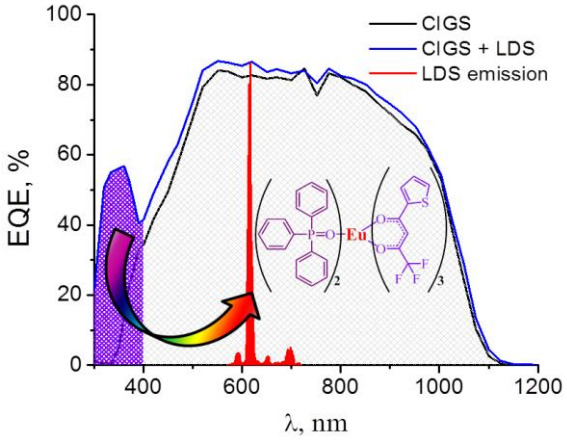

Figure 1. EQE spectra of CIGS solar cells with a DS layer.

[1] A. Gavriluta, T. Fix, A. Nonat, M. Paire, A. Slaoui, L. J. Charbonnière, J.-F. Guillemoles, *Adv. Optical Mater.*, DOI: 10.1002/adom.201600395.
[2] T. Fix, A. Nonat, D. Imbert, S. Di Pietro, M. Mazzanti, A. Slaoui, L. J. Charbonnière, *Prog. Photovolt.* **2016**, 24(9), 1251-1260.