Improving the efficiency of PV devices, via luminescent down-shifting of the incident light
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Introduction
Most photovoltaic (PV) technologies respond with different efficiencies to different wavelengths of the sunlight, exhibiting significantly lower efficiencies for blue and ultraviolet photons. The energy content of such photons can be harnessed more efficiently if they are absorbed by a luminescent species before reaching the semiconducting component of a PV device and then re-emitted at longer more favourable wavelengths. Where encapsulation within a polymer is used for sealing PV modules (>85% of the global market), it is possible to dissolve the luminescent species in the pre-existing encapsulation layer. Thus, the luminescent down-shifting (LDS) can be applied introducing no modification to the established manufacturing process. As a side effect of LDS, the modules are coloured, due to emission losses from their top and side planes, which can be useful in the developing area of building integrated PV (BIPV).

Objectives
• Review previous relative applications in the literature
• Establish through simulation which technologies can benefit and estimate the possible improvement.
• Identify suitability of available luminescent and host materials.
• Achieve improvement experimentally for multi-crystalline silicon (mc-Si) devices using the pre-existing polyethylene vinyl acetate (EVA) encapsulation layer as host matrix.
• Investigate other PV technologies and encapsulants.

Progress
• Complete review of previous relative applications [1].
• Ray-tracing simulations predicting positive result for mc-Si and CIS-based technologies.
• 10-18% absolute increase in external quantum efficiency (EQE) in the range 300-400nm, resulting in 1.2% relative improvement (0.18% absolute) in module efficiency achieved for mc-Si using Lumogen violet dye in EVA [2].

References

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