Tandem Luminescent Solar Concentrator based on Carbon Dots

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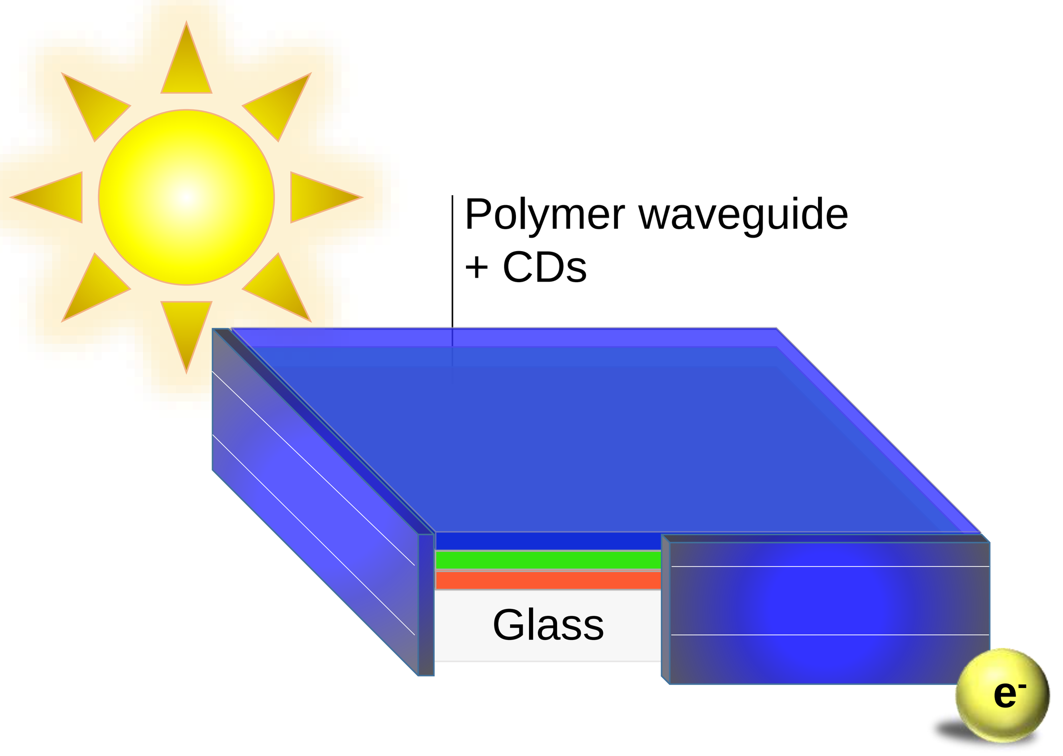
Introduction

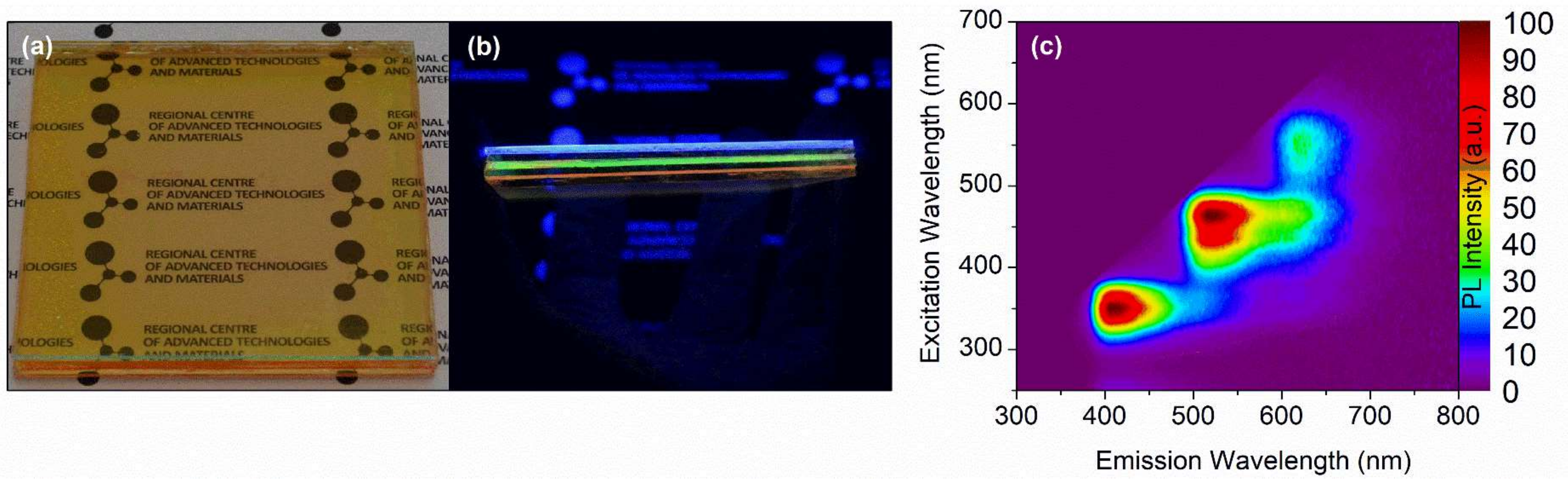


- **Luminescent solar concentrators (LSCs)** are light harvesting devices containing highly emissive fluorophores embedded or coated on the top of a transparent material [1].
- Absorbed solar light is reemitted at a lower energy by the fluorophores, and these photons are guided by total internal reflection to the device edges – LSCs are able to concentrate solar light from large surface areas to their edges.
- In the effort of reducing the solar electricity cost, LSCs have attracted noticeable attention during the last years. Because of their low cost and semi-transparency, LSCs could cover facades of urban buildings thus creating energetically self-sustainable units [2].

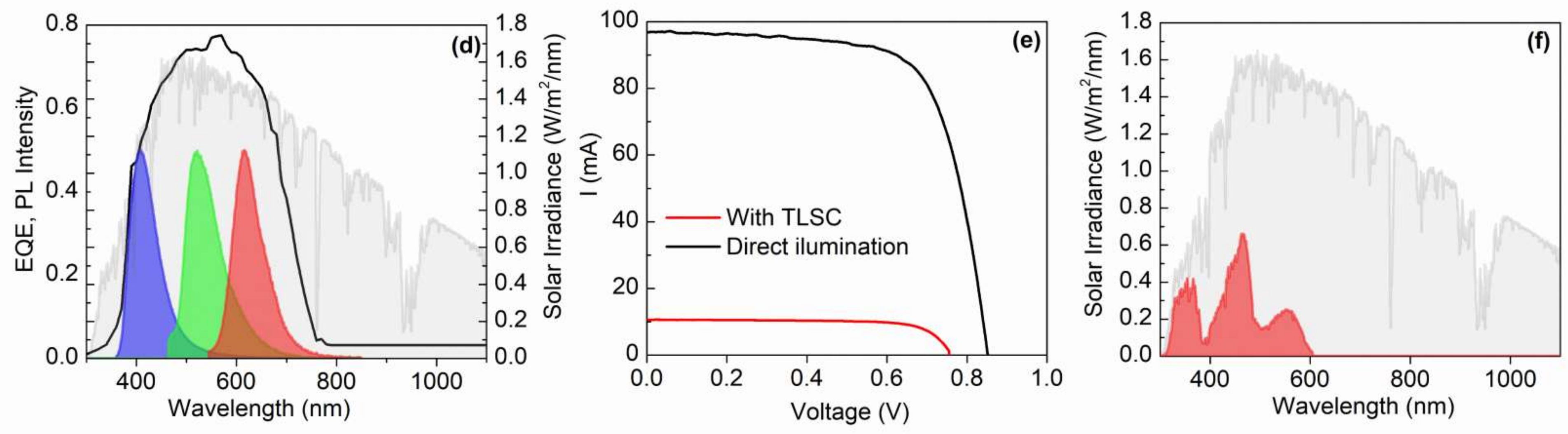
Overview of literature results for LSCs based on different types of fluorophores.

Fluorophore	Area (cm^2)	η_{int} (%)	η_{ext} (%)
Perovskite NCs [3]	100	26.0	0.9
Co-InP/ZnSe QDs [4]	100	37.2	4.7
CDs [5]	100	-	2.7

Optical Characterization of CD-LSC



Fabrication and characterization of the tandem LSC. **(a)** Photograph of the LSC under daylight, and **(b)** under weak UV illumination. **(c)** Excitation–emission color map.



(a) The EQE spectrum of a-Si solar cell is shown compared with AM 1.5G spectrum.
(b) *I-V* measurement of a-Si solar cell and tandem LSC coupled to the same solar cell.
(c) Global solar spectrum at air mass 1.5 (highlighted in grey) showing the fraction absorbed by the tandem LSC (highlighted in red)

Experimental setup for electro-optical measurements of tandem LSC coupled to a-Si solar cell

- Internal optical quantum efficiency (η_{int}):

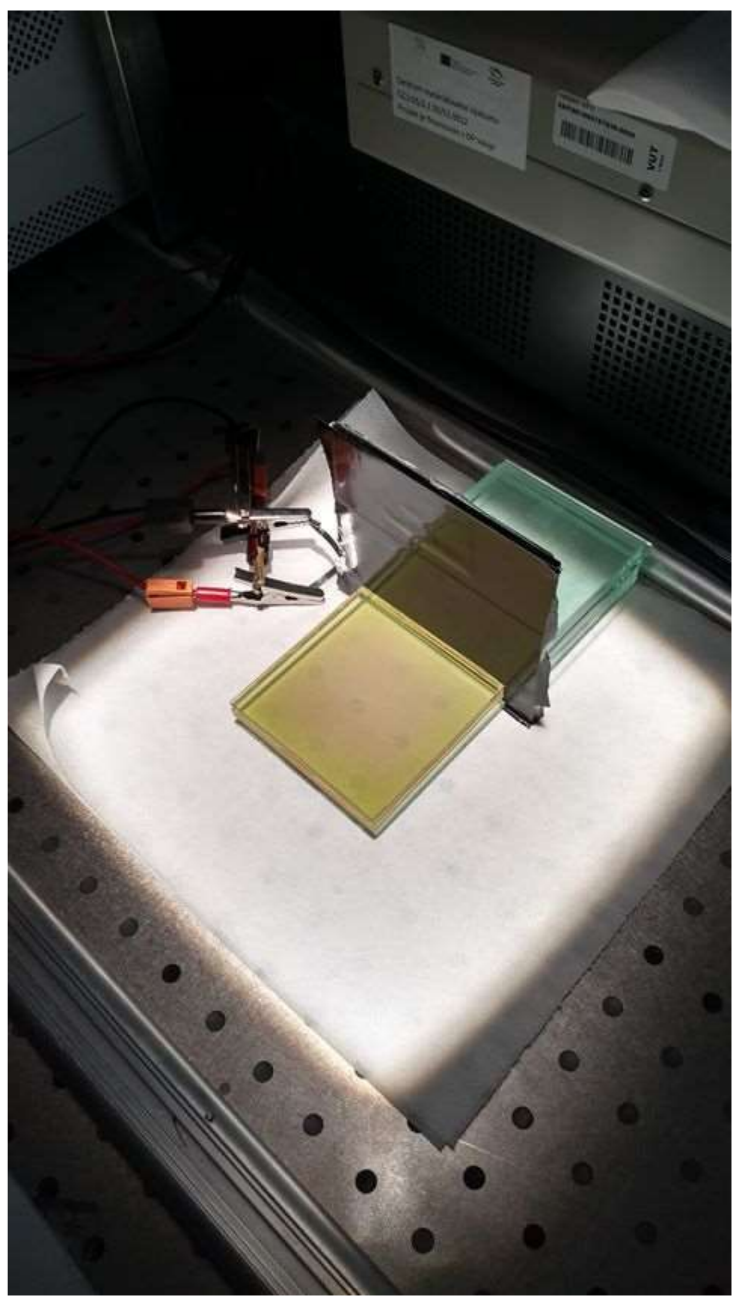
$$\eta_{int} = \frac{1}{G\eta_{s,abs}} \frac{I_{LSC}}{I_{PV}} \frac{Q_{total}}{Q_{PL}}$$

- External optical quantum efficiency (η_{ext}):

$$\eta_{ext} = \eta_{s,abs}\, \eta_{int}$$

$$\boldsymbol{\eta_{int} = 23.6\%}$$

$$\boldsymbol{\eta_{ext} = 2.3\%}$$



Challenges

- Utilization of nontoxic, ecofriendly and cheap fluorescent materials.
- Improvement of internal and external optical quantum efficiencies of LSCs.

Conclusions

- Large area (64 cm^2) tandem LSC based exclusively on blue-, green-, and red-emitting CDs encapsulated in polymer matrices is presented.
- Despite a high transparency over the visible spectrum (average transmittance of 83.4%), the fabricated device shows internal and external optical quantum efficiency of 23.6% and 2.3%, respectively [6].
- Due to these key merits, the fabricated LSC presents new opportunities for advanced solar light-harvesting technologies.

References
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