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Luminescent Solar Concentrators Employing Phycobilisomes[1]

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At current manufacturing growth rates, it is expected to take at least 20 years to produce enough Si-based solar cells to make a significant impact on the world energy supply. Solar concentrators could alleviate manufacturing constraints by focusing light on small solar cells. Luminescent solar concentrators (LSCs) are especially promising because they do not need to track the sun to obtain high optical concentration factors. Light incident on an LSC is absorbed by dyes, re- emitted into a guided mode in the slab, and finally collected by a PV cell mounted at the edge of the slab. The maximum optical concentration of an LSC is theoretically limited by the wavelength shift between absorption and emission in the dye. In this presentation, we describe LSCs that mimic a four energy level laser design, maximizing the wavelength shift and minimizing re-absorption losses. We employ phycobilisomes - photosynthetic antenna complexes that concentrate excited states in red algae and cyanobacteria. The phycobilisomes are cast in a solid-state matrix that preserves their internal Frster energy-transfer pathways and large wavelength shift between absorption and emission. Casting is a simple fabrication technique that also eliminates any need for expensive high-index glass or plastic. By comparing the performance of intact and decoupled complexes, we establish that energy transfer within intact phycobilisomes reduces LSC self-absorption losses by approximately (48$\pm$5)%. These results suggest that phycobilisomes are the model for a new generation of cast LSCs with improved efficiency at high optical concentrations.

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