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Research Article

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Effects of Luminous Solar Concentrator Parameters (Dyes Mixture, Host type and LSC Thickness) on the Si Solar Cell Performance Efficiency

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Abstract

Luminescent Solar Concentrator (LSC) plates have been prepared with different concentrations ($1*10^{-5}$, $2*10^{-5}$, $3*10^{-5}$, $5*10^{-5}$, $7*10^{-5}$, $1*10^{-4}$ Mol/L) of organic dye doped polymer. The optical properties of dye doped and un-doped polymer were measured and the solar to electric conversion efficiencies of several LSC modules based on R6G, and mixture of dyes (R6G & RB)doped in PMMA and Epoxy with different sample thickness were measured. It was found that the conversion efficiency depend on dye concentration in the LSC. The best conversion efficiency improvement for a modules Si-solar cell of dimensions of 10cm x 20cm covered with R6G ($3*10^{-5}$ mol/l concentration)doped PMMA LSC was6.927% (i.e. with efficiency incensement η=13.3% compared with the same module without LSC). Also it was found that LSC consists of mixture of dyes (R6G & RB with concentration 7E-5) doped PMMA had η=7.596%. This LSC exhibitsa potential to improve the Si solar cell performance efficiency, since a wide absorption and emission spectra will be used. The effect of epoxy as a host material for R6G in LSC was studied for the same concentration above. These results show that by using epoxy as a host for R6G ($2*10^{-5}$ concentration) had η=7.897% (i.e. efficiency increment η=14.4% compared with LSC for R6G doped PMMA). This is a promised results since epoxy resins can set at room temperature. However, epoxy resins have a poorer photostability compared with PMMA. Also the results include the effect of sample thickness on the conversion efficiency of Si solar cell.

Keywords: Luminescent Solar Concentrator; Optical properties; Solar conversion efficiency; Epoxy; PMMA, Rhodamine 6G dye and Rhodamine B dye.

1. Introduction

[1] Solar cells were used to convert renewable sun energy to electrical energy. Until recently, the cost of polysilicon, the starting material for solar cell production, has shown to represent higher than 30% of total solar system cost. This has motivated researchers to attempt to economies on the amount used per peak watt of power production. A possible solution to the challenge of minimizing the amount of silicon required is to use a concentrating system to collect sunlight over a large area and direct it on to a small area of solar cells. This reduces the amount of silicon used, while still producing the same power output. Efficiencies can actually be higher, because of the increased illumination intensity that the cell experiences (JG. Fossum *et al*, 1977; A. Goetzberger *et al*, 1977). Imaging concentrators use lenses, mirrors or a combination of both to focus sunlight on to the cells. While capable of achieving extremely high concentrations (several hundred suns), these require

precise tracking to follow the sun across the sky and keep the cells illuminated. Also, these are unable to make use of diffuse of diffuse solar radiation. An alternative is to use a non-imaging concentrator. There are several deferent ways of achieving this [A. Goetzberger *et al*, 1977; T.K. Mallick *et al,* 2007). We explore here one of these options – that of the luminescent solar concentrator (LSC)-which uses a sheet of luminescent material to trap both direct and diffuse solar radiation and transfer this energy to smaller areas of silicon cells to generate electricity(A. Goetzberger *et al*, 1977). The LSC was first proposed in the late 1970s as a means of concentrating solar radiation(W.H. Weber *et al* ,1976; A. Goetzberger 1978; A. Goetzberger *et al* , 1979). Extensive studies were made of LSC technology through the 1980s until the limitations of the fluorescent dyes available at that time hindered further development (P.S. Friedman, 1981; R. Reisfeld *et al*, 1988; M.G. El-Shaarawy etal,2003; JM. Drake *et al*, 1982).

The LSC is particularly suited to this application as it is relatively inexpensive, does not require solar tracking and works in both diffuse and direct sun

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