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Design and evaluation of a low-cost photovoltaic system with semi-diffuse structured Aluminium reflectors

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Abstract content
   (Max 300 words)

Abstract

The current energy production from fossil fuels and nuclear materials has serious environmental drawbacks. These include the creation of nuclear waste and the pollution associated with fossil fuels leading to global warming and climate change. It is therefore critical that an alternative and sustainable source of energy is found. A potential solution to this problem is solar electricity. Currently, solar panels are expensive and hence un-economical for most usage. The use of solar concentrators creates the possibility for less expensive electricity because concentrators raise the amount of incident radiation over a relatively small area of the absorber. The reduction in cost is achieved by reducing the module area and the use of low-cost reflectors. However, specular reflectors cause high concentrated heating and form hot spots on the solar module cells. The overall effect is the reduced fill-factor and overall efficiency of the system. In this paper, we report an alternative solution to the problem of non-even illumination by using locally available low-cost semi-diffuse reflectors with four different groove orientations scribed on it so as to scatter the radiation flux onto the module. This work therefore compared the following reflectors with no grooves or the plain sheets, with horizontal grooves, with vertical grooves, and the crisscross grooves orientations. Our results show that the locally purchased semi-diffuse aluminium materials can be used as a booster reflector compared with the commercial high specular reflector. The plain sheet with no grooves had the least fill-factor. The results also showed that the drop in the fill-factor from the reference value was about 3% for the crisscross and horizontal grooved structures, while that for vertical grooves and the plain sheet was about 8% and 12% respectively. The power output increased by 33% for the crisscross grooved, 52% for the horizontal grooves orientations. The vertical grooved and the plain sheet had 65% and 64% increase in power respectively. Although these two had high power, they resulted into high currents that cause hot spots. Hence the crisscross and horizontal grooved ones were the best materials as these scattered radiation flux and better fill-factor.
Key words: Semi-diffuse, specular, fill-factor, non-even illumination, low-concentration

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