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Broad absorption natural dye (Mondo-Grass berry) for dye sensitized solar cell

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Abstract Two major drawbacks in dye-sensitized solar cells (DSSC) are the narrow spectral response and the short-term stability. Research on development of artificial dyes for a broad frequency response is a major field of research today. The work presented here shows a broad response with a natural dye extracted from a Mondo-grass (*Ophiopogon japonicus*) berry. Its range of sensitivity covers the entire visible region and its tail expands to the near infrared. This is a unique situation since many natural dyes containing anthocyanin or carotenoids strongly absorbed only below 600 nm. A TiO_2 based electrode sensitized with Mondo grass berry dye DSSC was tested for its performance. An open circuit photovoltage of 495 mV and a short circuit photocurrent of 0.6 mA/cm^2 were obtained under 1 sun illumination. The broad spectral response from 400 to 750 nm was observed for the Mondo-grass berry dye. A high fill factor of 71% was achieved but energy conversion efficiency was only 0.2% for the cell. Even though cell efficiency is low with this dye, the solar cells have exhibited better stability when compared with that of the Blackberry. The thin layer chromatography results indicate that Mondo-grass berry dye contains a mixture of two or more chemical compounds belonging to both the anthocyanin and the carotenoid families.

1 Introduction

Solar cells are an attractive renewable energy source and are also promising devices for future energy needs. However, in order for solar cells to achieve their potential and penetrate into the global energy markets, it requires an expansion from the designing of high efficiency devices to the searching of new materials and methods that can deliver energy at a significantly lower cost. The dye-sensitized solar cells (DSSCs) have drawn a tremendous research interest due to their lower cost and easy fabrication compared to those of silicon solar cells [1, 2]. In DSSC, the dye is anchored to a wide band gap semiconductor. The most commonly used semiconducting material has been TiO_2 nano-sized particles. Charge separation takes place at the interface via photo-induced electron injection from the dye into the conduction band of the TiO_2. The cell properties such as fill factor (FF) and efficiency (η) are mainly dependent on the dye used as sensitizer. Generally synthesized dyes such as transition (heavy) metal compounds (ruthenium polypyridyl complexes) are very effective and the power conversion efficiencies reached thus far are about 11% with I^-/I_3^- electrolyte redox couple [3]. Not only do ruthenium polypyridyl complexes undergo an expensive and complicated synthesis process but they also contain an environmentally undesirable heavy metal. Alternatively, natural dyes can be used as the sensitizer with an adequate efficiency. There are an unlimited number of sources available to extract natural dye pigments as means of using in DSSC as sensitizer. Using natural dyes in solar cells is also advantageous due to their greener and lower cost.

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