EFFECT OF HEAT TREATMENT TO CLITORIA TERNATEA AND HIBISCUS SABDARIFFA-BASED DYE-SENSITIZED SOLAR CELLS' CHARACTERISTICS

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Abstract

In this paper, anthocyanin dyes produced from naturally occurring flowers of Clitoria ternatea and Hibiscus sabdariffa were used as sensitizers in dye-sensitized solar cells (DSSCs). The purpose of this study is to analyse the effect of pre-heat treatment towards the I-V performance of these two anthocyanins based-dye as natural dyes of Dye-Sensitized Solar Cell. The photovoltaic characteristics of Clitoria ternatea, Hibiscus sabdariffa and the combination of these flower-based dyes which supposedly produced a new purplish dye are investigated in this paper. The content of anthocyanin extracted from C. ternatea was evaluated using Ultraviolet-Visible Spectrophotometer (UV-VIS) to detect the light absorption behaviour. The performance of DSSCs was analysed with respect to the mix of anthocyanin-based extracts at varied pre-heated temperatures. Interestingly, the efficiency of C. ternatea-sensitized DSSC which the dye was pre-heated at 40 ° C increased significantly at almost 18 times higher than the C. ternatea's sample with non-heated condition. In addition, a new mixture dye of H. sabdariffa and C. ternatea excelled good improved values of cell efficiency, short-circuit current density and fill factor with 0.0023%, 24.244 μA/cm2, and 37.17%, respectively, compared than that of other fabricated samples. This mixed extract exhibited the greatest sensitization in the cell, which was consistent with the extract's broadest spectrum.

1 Introduction

Clitoria Ternatea, commonly known as butterfly pea, blue pea, blue vine, pigeon wings, mussel shell creeper and Bunga Telang is a plant species belonging to the family of Fabaceae [6]. The flower is used as a natural culinary colouring in Southeast Asia to colour sticky rice and sweets such as Eurasian putugal and an Ayurvedic medication. It is a significant element in nasi kerabu in Kelantan, in Peninsular Malaysia's northeast, giving it its unique bluish colour. The blossoms are frequently battered and fried in Burmese and Thai cuisines. *Hibiscus Sabdariffa*, also known as roselle, jamaica sorrel, red sorrel, Indian sorrel and asam susar is a plant species belonging to the family of Malvaceae. The calyx of Hibiscus Sabdariffa was discovered to have 'anthocyanin' as a primary pigment and was chosen as the natural dye for this study. The calyx contains cyanidin and delphinidin complexes, which are generally in the form of glycosides and are coupled to acyl functional groups [15]. These functional groups contribute to the colour stability of Hibiscus Sabdariffa extract and provide simple interaction with TiO_2 molecules. Photovoltaic solar energy is a renewable energy that has the potential to form a future clean, dependable, ascendable, and affordable electrical energy [11].This power source is gaining popularity since it is adaptable and provides several benefits to humans and the environment.

In 1839, Alexandre Edmond Becquerel, a 19-year-old French scientist, noticed a phenomenon of light-energy conversion in his father's laboratory. When two electrodes in an electrolyte were exposed to light, they produced little electric current, which he named the Photovoltaic (PV) effect Charles Fritts created the world's first solid-state cell in 1853 by covering selenium with a thin layer of gold to form the junctions. Albert Einstein described the primary mechanism of the photovoltaic effect in 1905, for which he received the Nobel Prize in Physics in 1921. Russell Ohl invented the contemporary junction semiconductor solar cell some years later, in 1946, which led to the invention of the transistor. In 1991, Michael Grätzel developed a sensitized electrochemical photovoltaic device using dye sensitization on semiconductor TiO_2 material and introduced the term "dye-sensitized solar cell" [1] [2] [5].

DSSC is an abbreviation for Dye-sensitized Solar Cell. It is a third-generation solar cell that is capable of absorbing variable light intensity and one of the most potential PV technologies available as an alternative to conventional silicon solar cells [10]. This new generation solar cell