

**ADVANCES  
IN MATERIALS  
ENGINEERING**  

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**Volume 2**

**Edited By:  
Md Abdul Maleque  
Iskandar Idris Yaacob  
Zahurin Halim**



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# Natural Dye Coated Nanocrystalline TiO<sub>2</sub> Electrode Films for DSSCs

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**Keywords:** Natural dyes, Solar cells, DSSCs, Liquid electrolyte, Solid electrolyte

**Abstract.** Nanocrystalline TiO<sub>2</sub> thin films were successfully prepared by dip-coating technique on ITO conductive glass substrates at low temperature. Dye-sensitized solar cells based on these films have exhibited high overall light-to-electricity conversion efficiency of 4.67 % under illumination intensity 100 mW/cm<sup>2</sup>.

## Introduction

Natural dyes find use in the coloring of textiles and food products (have nontoxic effects), drugs, cosmetics, etc. A huge number of plants all over the world can yield dyes. In addition to their dye-yielding characteristics, some of these plants also possess medicinal value. Though there is a large plant resource base, little has been exploited so far. Due to lack of availability of precise technical knowledge on the extracting and dyeing technique, it has not commercially succeeded like the synthetic dyes [1]. One more additional application of natural dyes is in the photovoltaic technology, particularly in the fabrication of dye sensitized solar cells.

Dye-sensitized solar cells (DSSCs) based on nanocrystalline TiO<sub>2</sub> thin film electrodes have been attracting a lot of interests due to high energy conversion efficiencies and low production cost [2-4]. Nanocrystalline TiO<sub>2</sub> thin film electrodes are commonly prepared by coating TiO<sub>2</sub> colloid with organic additives on conductive glass substrates and annealing at high temperature of 450°C-500 to remove °C organic additives and connect TiO<sub>2</sub> particles to form mechanically stable film.

In this chapter, a nanocrystalline TiO<sub>2</sub> thin film electrodes was prepared at room temperature and optimized Ti (IV) precursors and the solvents.

## Experimental

A commercial nanocrystalline TiO<sub>2</sub> powder (Degussa P25 70 % anatase and 30 % rutile) was mixed with 3.6 g of a 1 mol/L *n*-butanolic solution of tetrabutyl titanate [Ti (OC<sub>4</sub>H<sub>9</sub>)<sub>4</sub>] and stirred in a closed glass container for about 2 h to obtain a paste of appropriate viscosity. The raw films were produced by coating the paste with doctor-blade method on the glass substrates (ITO), and then dried at room temperature. The raw films can be treated by cooked in a container full of water at 100°C for 4 h. The raw and treated films were heated at 100°C for 1 h, and then immersed in a 0.0005 mol/L ethanol solution of natural dye overnight at room temperature. The cells employed dye adsorbed films as the working electrodes and platinum foils as the counter electrodes to assemble the sandwich DSSCs. The electrolyte was