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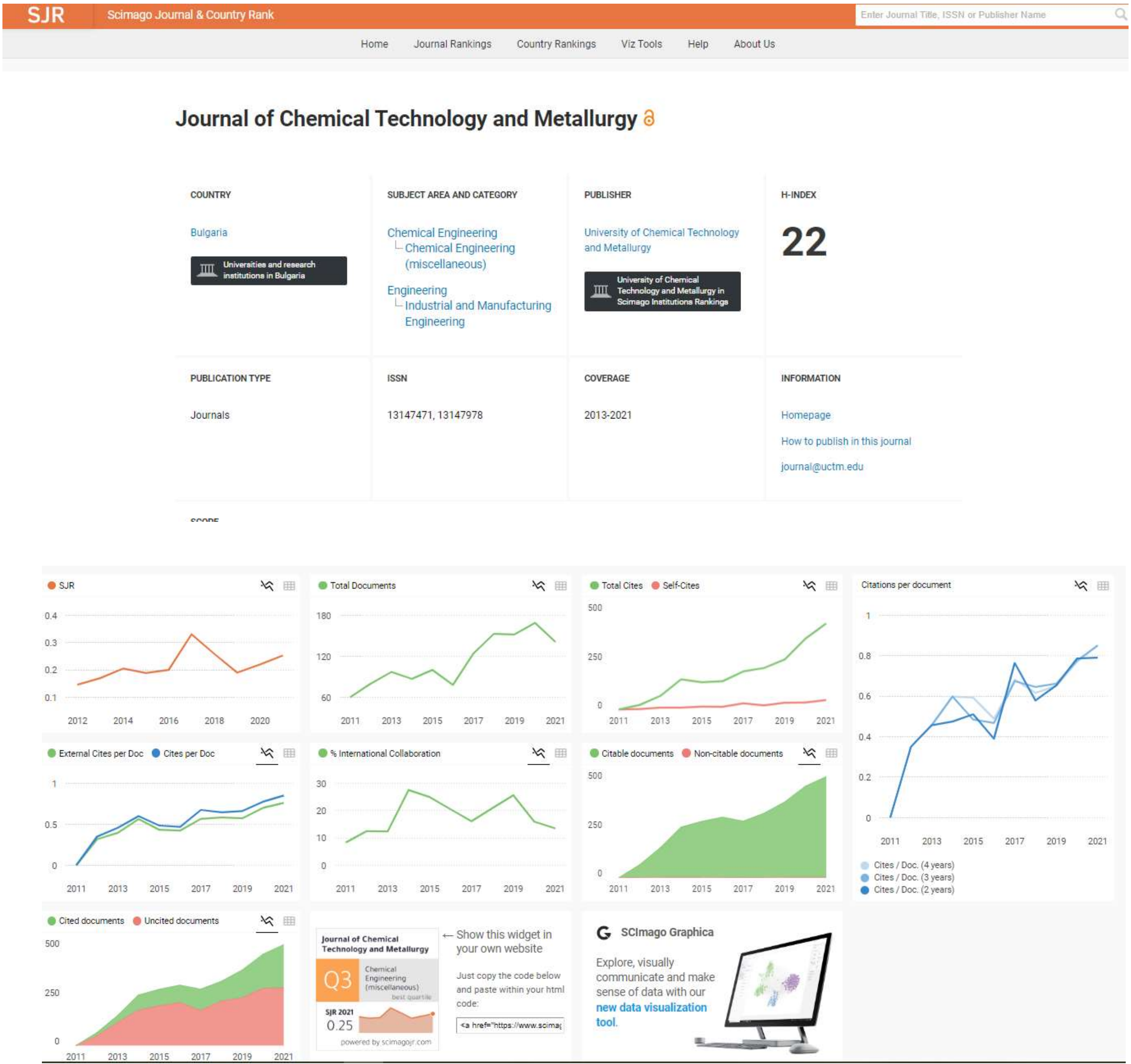

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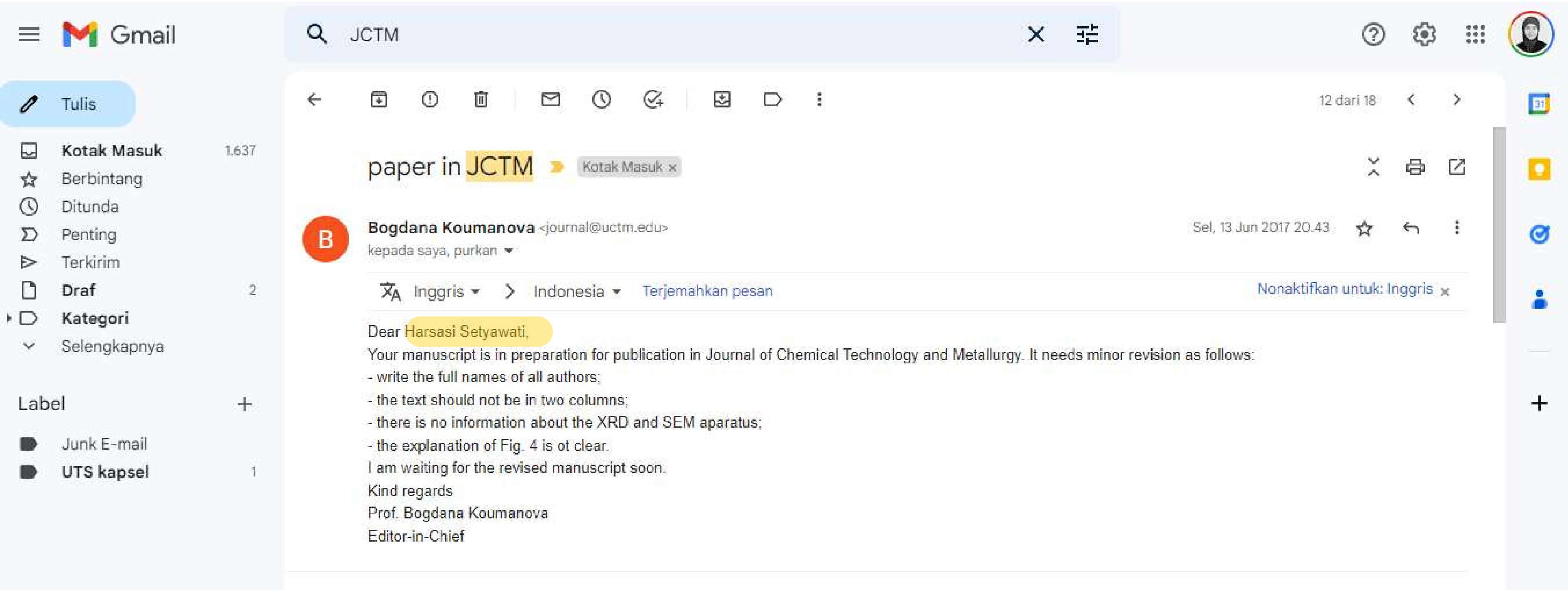

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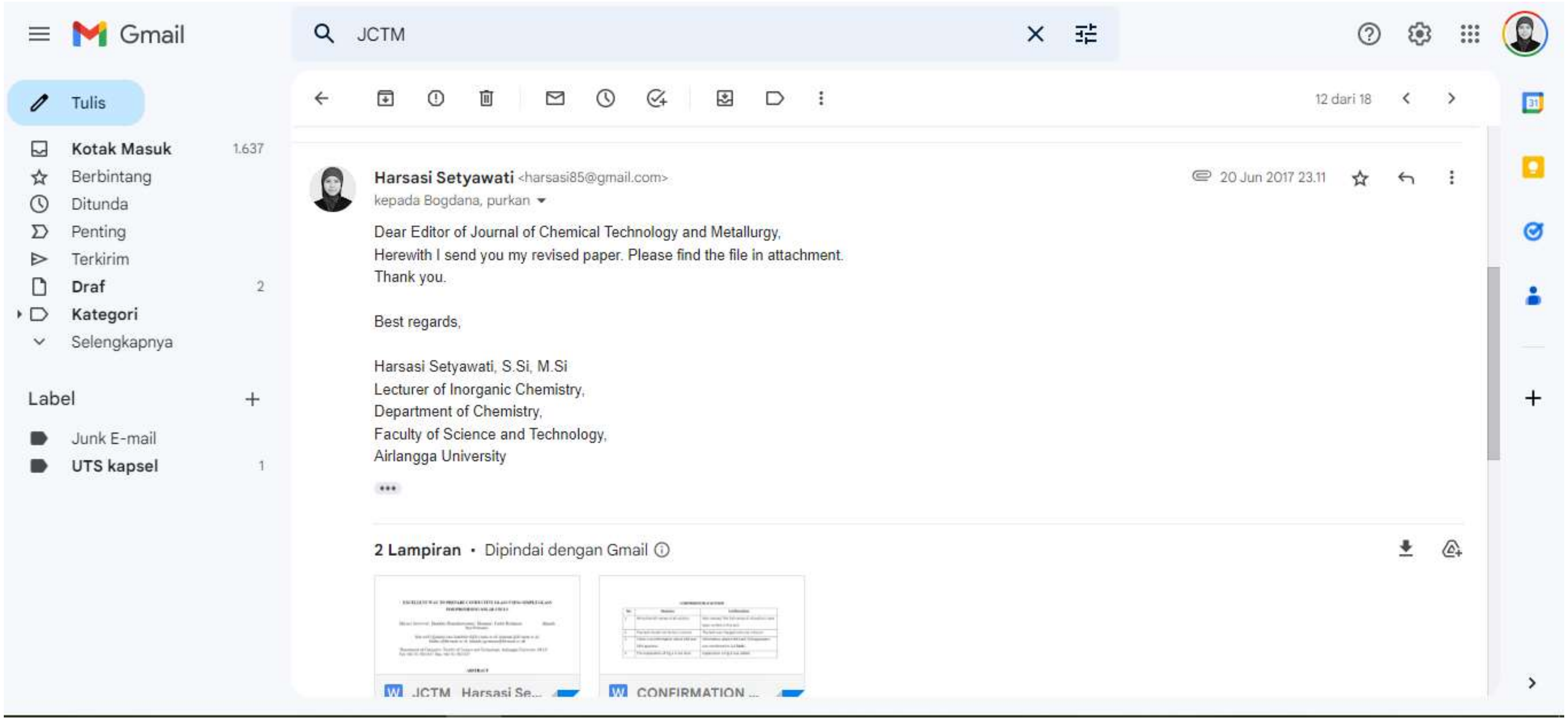

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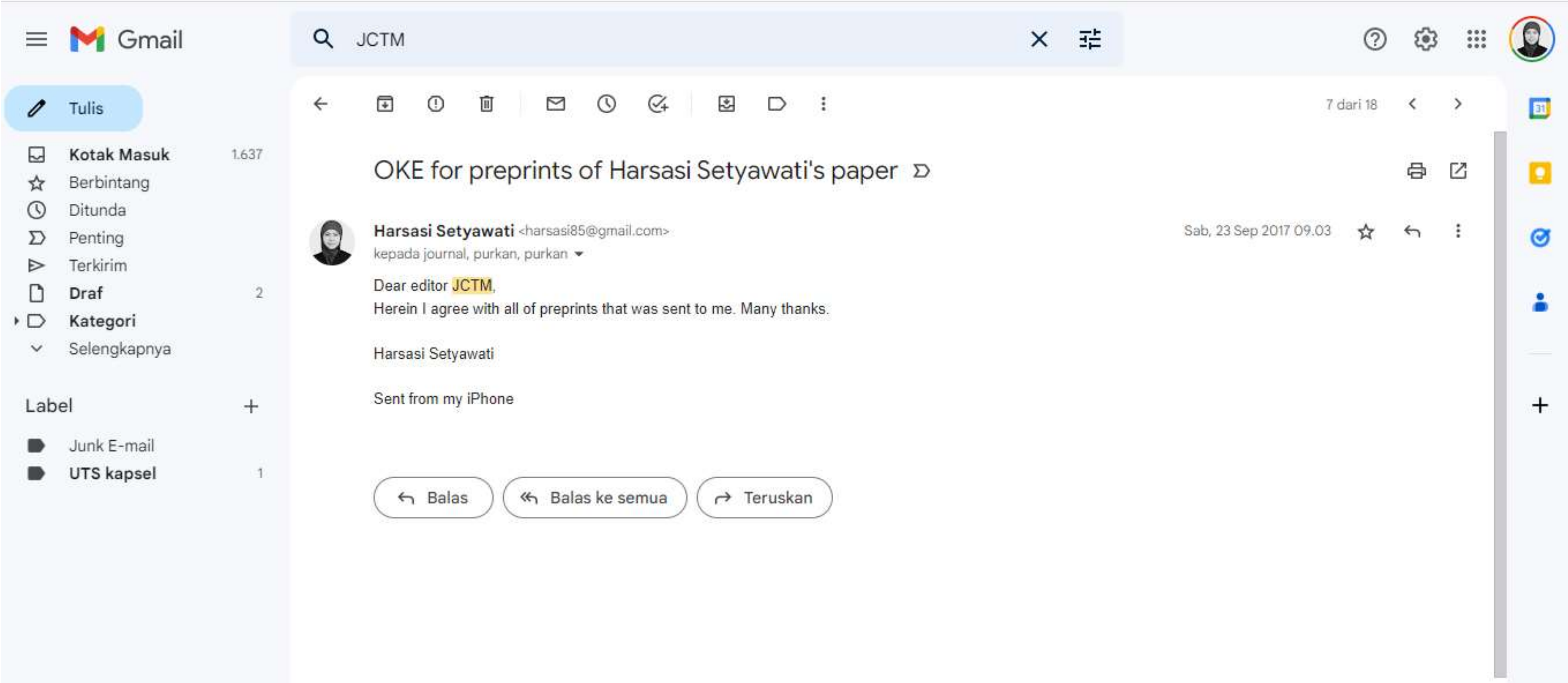

AN EXCELLENT WAY TO PREPARE CONDUCTIVE GLASS USING A SIMPLE GLASS PLATE AIMING A PROMISING SOLAR CELL

Harsasi Setyawati, Handoko Darmokoesoemo, Hamami, Faidur Rochman, Ahmadi Jaya Permana

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ABSTRACT

The conductive glass is a solar cell main component. The thickness of TiO_2 acting as a semiconductor plays a primary role in the transmission, photoconductive properties, and the efficiency of solar cells. This research advances an excellent method to obtain a promising conductive glass for solar cells fabrication through coating a simple commercial soda lime glass by a thin layer of TiO_2. The product described shows higher efficiency than that of fluorine thin oxide glass which is currently used in solar cells. Its application is expected to overcome the high cost of solar cells.

Keywords: excellent, conductive, glass, simple, thin layer, TiO_2.

INTRODUCTION

Solar energy is one of the best alternatives of renewable energy resource because it is safe, clean and effective [1]. On other hand, its current efficiency is still poor and has to be improved. Many researchers work on inventing suitable techniques for the production of the best solar cell component [2 - 4]. Many experiments have been done to improve the efficiency of the solar cell since the discovery of the nanostructured dye-sensitized solar since the discovery of the nanostructured dye-sensitized solar cell (DSSC). One of the solutions is to prepare conductive glass through coating an affordable glass plate by a thin semiconductor layer. This approach provides the opportunity to have cheaper solar cells by using a small amount of materials and low-cost fabrication technologies [5, 6]. The aim of this study is to prepare conductive glass by deposition of a thin layer of titanium dioxide on a plate of simple commercial soda lime glass. The product expected can decrease the costs of fabricating solar cells.

EXPERIMENTAL

Titanium(IV) isopropoxide ($Ti(OC_3H_7)_4$) (TTIP), 4-(1,1,3,3-tetramethylbutyl) phenyl polyethylene glycol (Triton X-100), iodine (I_2), potassium iodide (KI), acetic acid (CH_3COOH), hydrochloric acid (HCl), ethanol (CH_2CH_3OH) and ether. Dye sensitizer used was rhodamine B were used in this study. FTO (*Fluorine doped Tin Oxide*) glass from *Latech scientific supply Pte. Ltd Singapore* (10 Ω, 25 x 25 x 3.2 mm), simple soda lime glass (25 x 25 x 1.2 mm), a graphite pencil and binder clips were also used.

The structure of the thin TiO_2 layer was characterized by XRD (X' pert PRO Diffractometer) and SEM (Carl zeiss EVO MA 10 English). The DSSC cell performance was followed by a multimeter Dekko using a potentiometer circuit. The solar irradiance was measured by Light Meter Krisbow KW06-288.

The procedures applied referred to:

- **Preparation of a glass plate using commercial soda lime glass**

Commercial soda lime glass of a thickness of 1.2 mm was cut to square plates of 25 mm x 25 mm size. They were sanded and coated with TiO_2 sol to produce a thin layer of titanium dioxide.

- **Preparation of TiO_2 sol for coating a glass plate**

A thin layer of titanium dioxide was deposited by the sol-gel method. 5 mL of triton X -100 were added to acetic acid and then transferred to 225 mL of ethanol while stirring for 3 min. 15 mL of TTIP dissolved in 1 mL of concentrated hydrochloric acid were added to the solution. The mixture was stirred for 2 h to form a sol [7].

- **Simple glass plate coating by TiO_2 sol**

Titanium dioxide sol was dropped onto the glass plate. The droplets were leveled through swiping the surface by another glass plate. The sample prepared was dried in an oven for 10 min at 80°C. The procedure described is performed three times on the same glass plate. Then the latter was calcinated for 2 h at 450°C [8]. The preparation procedure is illustrated in Fig. 1.

- **Performance of the conductive glass prepared in a solar cell**

The performance of the conductive glass prepared was tested by juxtaposing it to the FTO glass as a working electrode in a solar cell. Aiming this the both samples were immersed in 10^{-2} M rhodamine B as a dye sensitizer for 24 h. Thus they became ready to act as working electrodes. The corresponding counter electrodes were prepared in the following way. A homogeneous scratch of a graphite pencil was left on two other glass plates. They were left in contact with combustion soot until a homogenous surface was obtained. The counter electrodes were attached to the working electrodes and clamped with a binder clip (Fig. 2). An electrolyte solution containing I_2 dissolved in KI was dropped between each two electrodes. The DSSC cells thus obtained were connected to two multimeters to measure their current and voltage [2]. The working electrode acted as a cathode, while the counter electrode as an anode. At the same time, the sunlight intensity was measured by a light meter.

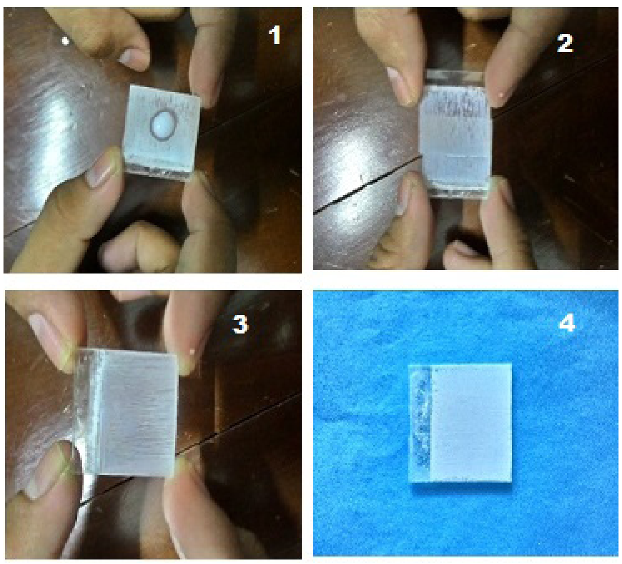

Fig. 1. Preparation of conductive glass using a simple glass plate and a thin layer of TiO_2.

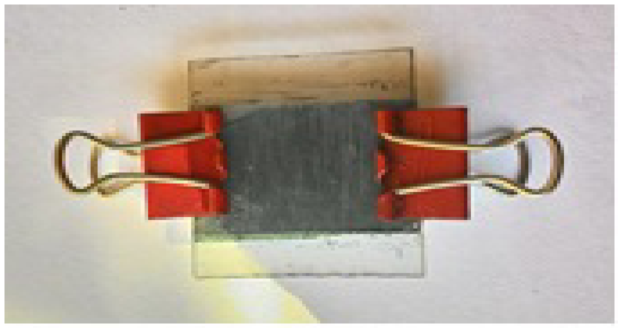

Fig. 2. DSSC cells.

RESULTS AND DISCUSSION

The conductive glass developed in the course of this research is juxtaposed to FTO glass acting as working electrodes in a solar cell using rhodamine B as a dye sensitizer.

The diffractogram of the thin layer of TiO_2 shows three peaks at 25.2926°; 37.9248°; 48.1980° (Fig. 3).

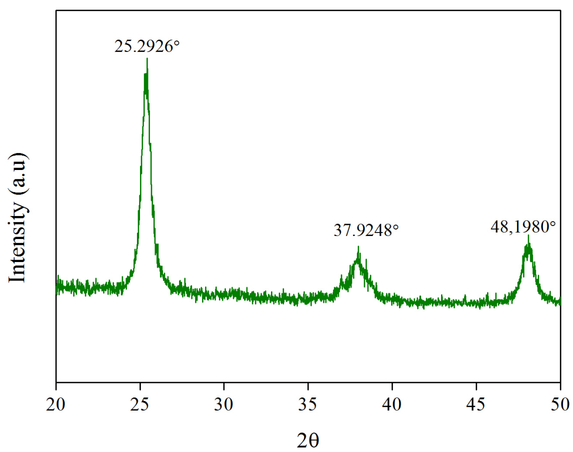

Fig. 3. The diffractogram of TiO_2 thin layer deposited on a simple glass plate.

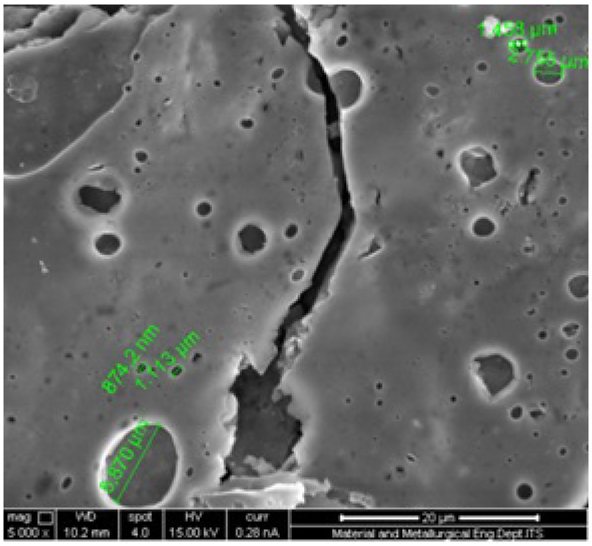

Fig. 4. SEM images of the surface of the thin TiO_2 layer deposited on simple glass plate (zoom 5000x).

It is compared to the diffractogram of anatase TiO_2 on the standard spectrum card JCPDS No. 88-1175 and 84-1286. Anatase TiO_2 has a larger surface area than TiO_2 rutile facilitating dye sensitizer attachment [10].

The thin TiO_2 layer obtained is characterized by SEM and the results are shown in Fig. 4. It is evident that surface pores are formed. The pore diameter is diverse – it ranges between 874.2 µm and 8,870 µm. The pores formed increase the surface area and contribute to the solar cell dye (Dye Sensitized Solar Cells) attachment. This condition is very advantageous because the increase of the dye attached to the semiconductor results in increase of solar cell capability to capture solar energy and generate a larger electric conversion [11].

Figs. 5 and 6 show the current and voltage obtained using both working electrodes. The current and voltage recorded on the conductive glass developed in the course of this research have higher values from day to day than those found using FTO glass. The highest values of the current and the voltage refer to 48 mA and 0.5 V. This indicates that the glass advanced has a potential to be used as conductive glass in a solar cell.

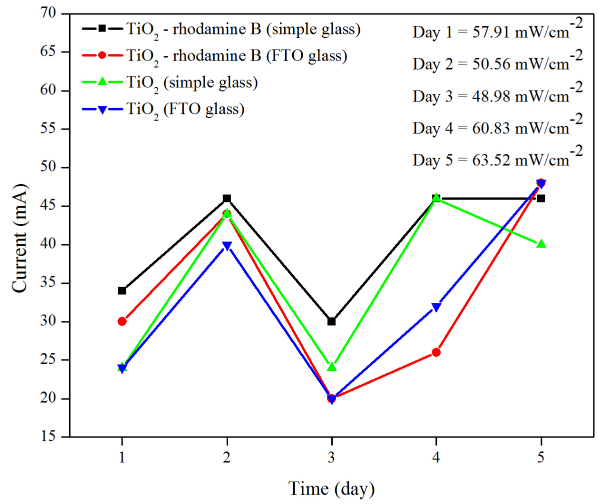

Fig. 5. Current vs time curve.

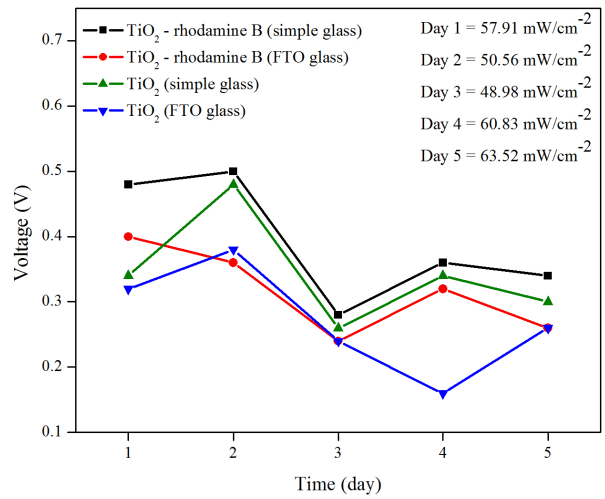

Fig. 6. Voltage vs time curve.

Table 1. Performance of DSSC cells.

	Glass Type	Average		FF	Efficiency (%)
		Voc (V)	Isc (mA)		
TiO_2	FTO	0.3552	0.0160	0.0995	0.00054
TiO_2- rhodamine B	FTO	0.4543	0.0400	0.1126	0.00194
TiO_2	Simple Glass	0.3552	0.0120	0.4272	0.00173
TiO_2- rhodamine B	Simple Glass	0.4552	0.0064	0.6096	0.00169

Solar irradiance = 26.307 W/m²

Table 1 shows that the conductive glass developed produces Voc/Isc higher than that of FTO glass i.e. 0.3553 V / 0.0120 mA for TiO_2 and 0.4552 V/0.0064 mA for TiO_2-rhodamine B. The same is valid for the efficiency as well. The values estimated refer to 0.00173 % for TiO_2 and 0.00169 % for TiO_2-rhodamine B. These results verify that the glass obtained through deposition of a thin TiO_2 layer on a simple glass plate can be applied as conductive glass in a solar cell.

CONCLUSIONS

The research reported shows that the thin layer of titanium dioxide deposited on a plate of commercial soda lime glass plate has an anatase structure and pores providing a high surface area, which in turn facilitate dye sensitizer binding. The conductive glass described has an efficiency of 0.00169 %, which is higher than that of FTO glass.

Acknowledgements

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