

VOLUME 49
ISSUE 6, 2014



ISSN 1314-7471 (print)
ISSN 1314-7978 (on line)
www.uctm.edu

JOURNAL

**OF CHEMICAL TECHNOLOGY
AND METALLURGY**



SOFIA 2014

Volume 52, Iss. 6, 2017

Submitted by stanislav on Thu, 09/28/2017 - 20:40

Journal of Chemical Technology and Metallurgy

52, Iss. 6, 2017
ISSN 1314-7471 (print)
ISSN 1314-7978 (on line)

EDITOR-IN-CHIEF

Prof. Dr. Bogdana Koumanova

Tel: (+ 359 2) 81 63 302

University of Chemical Technology and Metallurgy

8 Kl. Ohridski, 1756 Sofia, Bulgaria

E-mail: journal@uctm.edu

SELECTED ARTICLES

International Conference

“Collaboration Seminar of Chemistry and
Industry (CoSCI-2016)”

5-6 October, 2016

Surabaya, Indonesia

Invited Editor

Dr. Purkan Purkan

[Primary study of cellulose acetate hollow fiber as a green membrane applied to hemodialysis](#)

Yanuardi Raharjo, Siti Wafiroh, Mahdya Nayla, Vita Yuliana, Mochamad Zakki Fahmi

[Composite beads of chitosan/bentonite as a matrix for phosphate fertilizer controlled-release](#)

Bambang Piluharto, Veinardi Suendo, Ida Maulida, Asnawati

[Serum acetaldehyde as a potential biomarker for the detection of pathogenic biofilm formation by *Candida albicans*](#)

Masfufatun, Sumayyah Luqman Bayasud, Mei Shirli Yasinta, Ni'matuzahro, Afaf Baktir

The influence of ascorbic acid, creatine, and creatinine on the uric acid analysis by potentiometry using a carbon paste modified imprinting zeolite electrode

Miratul Khasanah, Muji Harsini, Alfa Akustia Widati, Prihantari Mukti Ibrani

A novel spectrophotometric method for determination of histamine based on its complex reaction with Cu(II) and alizarin red S

Miftakhul Jannatin, Ayu Nabila I.L, Ganden Supriyanto, Pratiwi Pudjiastuti

Application of ionic liquid dispersive liquid-liquid microextraction for analysis of n-nitrosodipropylamine in salted fish

Aning Purwaningsih, Yanuardi Raharjo, Hendarta Agasi

Determination of chlorpyrifos pesticide by effervescence liquid phase microextraction HPLC UV-Vis

Usreg Sri Handajani, Yanuardi Raharjo, Bagas Wantoro

Effect of aliphatic and aromatic hydrocarbons on the oxygenase production from hydrocarbonoclastic bacteria

Sri Sumarsih, Ni'matuzahroh, Fatimah, Miranti Puspitasari, Meilisa Rusdiana

Identification of *Candida* species by assimilation and Multiplex-PCR methods

Hermansyah, Nurmalina Adhiyanti, Julinar, Kemas Yakub Rahadiyanto, Susilawati

Xylanase enzyme from a local strain of *Pseudomonas stutzeri*

Purkan Purkan, Emma Huruniawati, Sri Sumarsih

Study of a catalyst of citric acid crosslinking on locust bean gum

Wuryanto Hadinugroho, Suwaldi Martodihardjo, Achmad Fudholi, Sugeng Riyanto

Production and characterization of sulfonated chitosan-calcium oxide composite membrane as a proton exchange fuel cell membrane

Siti Wafiroh, Abdulloh, Winda Kusuma Wardani

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

Partial oxidative synthesis of fluorescent carbon derived from local bamboo leaves

Ahmadi Jaya Permana, Abdul Haris, Harsasi Setyawati, Mochamad Zakki Fahmi

Stability of coordination compounds obtained by reduction of copper(II) halide and 1,3-bis(diphenylphosphino)propane (DPPP)

Nike Prilil Puspita Sari, Lis Siaturohmah, Effendy, Fariati

Phenolic compounds from *Aquilaria microcarpa* stem bark

Alfinda Novi Kristanti, Mulyadi Tanjung, Okky P. Rahayu, Erika Herdiana

Electrochemical degradation of naphthol AS-BO batik dyes

Muji Harsini, Suyanto, Yhosep Gita Y. Y., Lilik Rhodifasari, Handoko Darmokoesomo

Silica-methyltrimethoxysilane based hydrophobic coatings on a glass substrate

Alfa A. Widati, Nuryono Nuryono, Indriana Kartini, Noah D. Martino

Chitosan-based neem seed extract nanocapsules: a new approach on enhancing its effectiveness as an insecticide delivery agent

Mochamad Zakki Fahmi, Hery Suwito, Achmadi Susilo, Erika Joeniarti, Anninda Mughniy Rahayu Jaswadi, Nindayu Indrasari

Confusarin and nudol, two phenanthrene group compounds, from *Dioscorea esculenta* L. and their antioxidant activities

Nanik Siti Aminah, Ratih Hidayah, Mulyadi Tanjung

Drug delivery hard shell capsules from seaweed extracts

Pratiwi Pudjiastuti, Muhammad Al Rizqi Dharma Fauzi, Handoko Darmokoesoemo

Organic template free hierarchical ZSM-5 prepared by desilication

Hartati, Alfa Akustia Widati, Aning Purwaningsih, Alfinda Novi Kristanti, Anggarani Nur Oktavia

Modification of Gresik's dolomite to CaO•MgO nanocomposite as a catalyst for synthesis of biodiesel from tamanu oil

Abdulloh Abdulloh, Alfa Akustia Widati, Oditio Arizal

Editorial Board

Submitted by admin on Wed, 08/13/2014 - 15:36

EDITOR-IN-CHIEF

Prof. Dr. Bogdana Koumanova

University of Chemical Technology and Metallurgy, Bulgaria

S.J. Allen, Queens University of Belfast, UK

N.Yu. Bashkirceva, National Research Technological University, Kazan, Russia

M. Bojinov, University of Chemical Technology and Metallurgy, Bulgaria

V. Bojinov, University of Chemical Technology and Metallurgy, Bulgaria

J. Carda, University Jaume I, Castellon, Spain

G. Cholakov, University of Chemical Technology and Metallurgy, Bulgaria

D. Danalev, University of Chemical Technology and Metallurgy, Bulgaria

V. Dimitrov, Bulgarian Academy of Sciences

N. Dishovsky, University of Chemical Technology and Metallurgy, Bulgaria

S.J.C. Feyo de Azevedo, Universidade do Porto, Portugal

M. Jitaru, University "Babeş -Bolyai", Cluj-Napoca, Romania

S. Kalcheva, University of Chemical Technology and Metallurgy, Bulgaria

F. Keil, Hamburg University of Technology, Germany

T. Koinov, University of Chemical Technology and Metallurgy, Bulgaria

T. Komatsu, Nagaoka University of Technology, Japan

M. Kucharski, AGH University of Science and Technology, Krakow, Poland

J.M. LeLann, Institut National Polytechnique, École nationale supérieure des

S.N. Lezhnev, Karaganda State Industrial University, Kazakhstan

A. Mavrova, University of Chemical Technology and Metallurgy, Bulgaria

I.P. Mazur, Lipetsk State Technical University, Russia

D. Mehandjiev, Bulgarian Academy of Sciences

V. Meško, International Balkan University, Skopje, Macedonia

E. Mihailov, University of Chemical Technology and Metallurgy, Bulgaria

L. Mörl, University "Otto-von-Guericke", Magdeburg, Germany

B. Nath, European Centre for Pollution Research, London, UK

L. Petrov, Bulgarian Academy of Sciences

A. K. Pogodaev, Lipetsk State Technical University, Russia

G. Radeva, University of Chemical Technology and Metallurgy, Bulgaria

A. Di Schino, University of Perugia, Italy

M. Simeonova, University of Chemical Technology and Metallurgy, Bulgaria

V. Stefanova, University of Chemical Technology and Metallurgy, Bulgaria

D. Stoilova, Bulgarian Academy of Sciences

N. Tsarevsky, Southern Methodist University, Dallas, Texas, USA

ingénieurs en arts chimiques et technologiques,
France

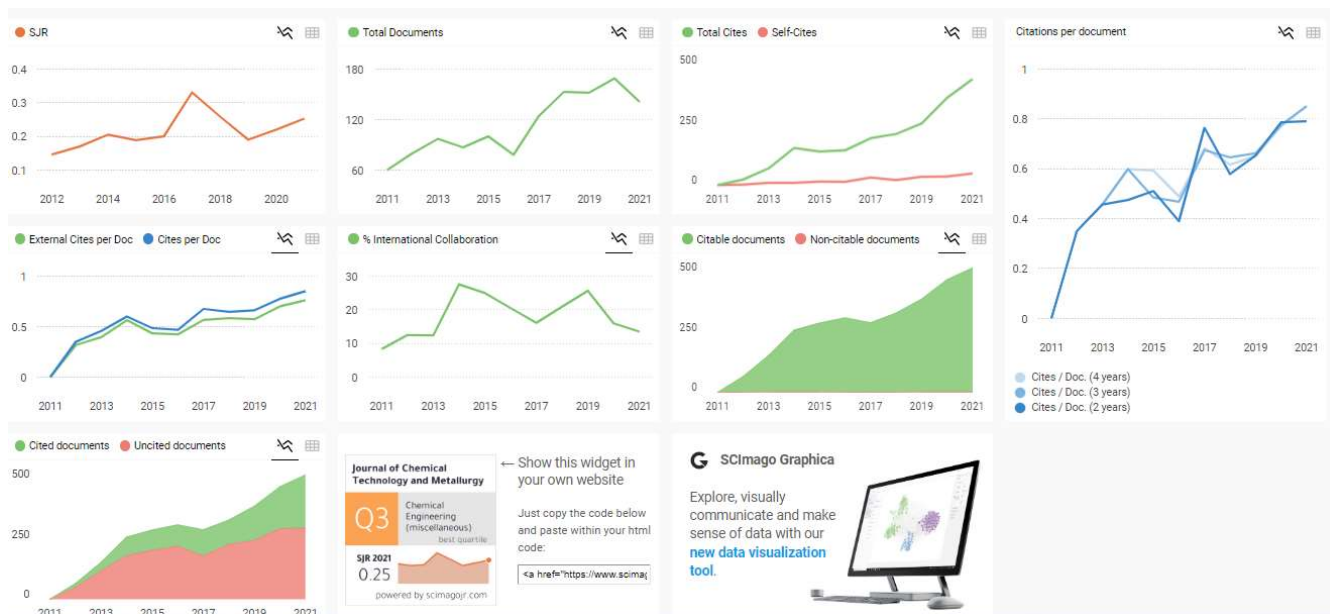
I. Turunen, Lappeenranta University of
Technology, Finland

L. Vezenkov, University of Chemical
Technology and Metallurgy, Bulgaria

BUKTI SCOPUS

Journal of Chemical Technology and Metallurgy

COUNTRY Bulgaria 	SUBJECT AREA AND CATEGORY Chemical Engineering ↳ Chemical Engineering (miscellaneous) Engineering ↳ Industrial and Manufacturing Engineering	PUBLISHER University of Chemical Technology and Metallurgy 	H-INDEX 22
PUBLICATION TYPE Journals	ISSN 13147471, 13147978	COVERAGE 2013-2021	INFORMATION Homepage How to publish in this journal journal@uctm.edu



Journal of Chemical Technology and Metallurgy

Q3 Chemical Engineering (miscellaneous) Best quartile

SJR 2021 0.25

powered by scimagojr.com

← Show this widget in your own website

Just copy the code below and paste within your html code:

```
<a href="https://www.scimagojr.com" data-bbox="465 675 550 685">
```

SCImago Graphica

Explore, visually communicate and make sense of data with our **new data visualization tool**.



BUKTI KORESPONDENSI

The screenshot shows a Gmail interface with a search bar containing "JCTM". The left sidebar lists folders: "Tulis", "Kotak Masuk" (1,637), "Berbintang", "Ditunda", "Penting", "Terkirim", "Draf" (2), "Kategori", "Selengkapnya", "Label", "Junk E-mail", and "UTS kapsel" (1). The main content area displays an email from "Bogdana Koumanova <journal@uctm.edu>" to "saya" (me), dated "Sel, 13 Jun 2017 20.43". The subject is "paper in JCTM". The email body contains the following text:

Dear Harsasi Setyawati,

Your manuscript is in preparation for publication in Journal of Chemical Technology and Metallurgy. It needs minor revision as follows:

- write the full names of all authors;
- the text should not be in two columns;
- there is no information about the XRD and SEM apparatus;
- the explanation of Fig. 4 is not clear.

I am waiting for the revised manuscript soon.

Kind regards
Prof. Bogdana Koumanova
Editor-in-Chief

BUKTI KORESPONDENSI

The screenshot shows a Gmail interface with a search bar containing 'JCTM'. The email is from Harsasi Setyawati (harsasi85@gmail.com) to Bogdana, dated 20 Jun 2017 at 23:11. The email text reads: 'Dear Editor of Journal of Chemical Technology and Metallurgy, Herewith I send you my revised paper. Please find the file in attachment. Thank you. Best regards, Harsasi Setyawati, S.Si, M.Si, Lecturer of Inorganic Chemistry, Department of Chemistry, Faculty of Science and Technology, Airlangga University'. Two attachments are visible: a PDF document titled '.JCTM Harsasi Se...' and a 'CONFIRMATION ...' document.

Gmail Interface:

- Search: JCTM
- Navigation: 12 dari 18
- Sender: Harsasi Setyawati <harsasi85@gmail.com>
- Recipient: kepada Bogdana, purkan
- Date: 20 Jun 2017 23.11
- Text: Dear Editor of Journal of Chemical Technology and Metallurgy, Herewith I send you my revised paper. Please find the file in attachment. Thank you. Best regards, Harsasi Setyawati, S.Si, M.Si, Lecturer of Inorganic Chemistry, Department of Chemistry, Faculty of Science and Technology, Airlangga University
- Attachments: 2 Lampiran • Dipindai dengan Gmail
- Attachment 1: .JCTM Harsasi Se...
- Attachment 2: CONFIRMATION ...

BUKTI KORESPONDENSI

The screenshot shows a Gmail interface with a search bar at the top containing "JCTM". The left sidebar displays the "Kotak Masuk" (Inbox) with 1,637 emails, and a "Label" section with "Junk E-mail" and "UTS kapsel" (1). The main content area shows an email from "purkan purkan" (purkan@fst.unair.ac.id) dated 31 Jul 2017 08.08. The subject is "koreksi inggris dari JCTM". The email body contains the following text:

Bapak ibu author journal JCTM Yth

Editor in chief dari jurnal JCTM telah mengoreksi bhs inggris dari manuscript bapak ibu, isinya adalah :

- in red colour is the corrected English
- in blue colour is the text that needs clearing or has been repeated;

Author yang akan memberikan pembetulan, mohon dibuat dinaskah ini dengan memberi warna hijau atau kuning. Kemudian dikirimkan ke Bogdana beserta file awal yang koreksi editor. Jika tidal ada koreksi warna biru, mohon diberikan konfirmasi OKE ke Bo dengan cc ke saya.

Bogdana ingin konfirmasi segera. Mungkin kalo koreksinya hanya red colour, perlu bisa langsung konfirmasi, karena dia sedang menunggu ada perwakilan yang sudah reply. Bulan agustus tidak ada pengiriman naskah, karena kampus libur, Koreksi lanjutna akan diberikan pada awal september.

File saya kirim dalam bentuk rar zip, mohon bapak ibu memilih filenya sendiri-sendiri.

Terima kasih salam
Purkan

BUKTI KORESPONDENSI

The screenshot shows a Gmail interface with a search bar containing 'JCTM'. The left sidebar lists folders: 'Kotak Masuk' (1,637), 'Berbintang', 'Ditunda', 'Penting', 'Terkirim', 'Draf' (2), 'Kategori', and 'Selengkapnya'. Under 'Label', there are 'Junk E-mail' and 'UTS kapsel' (1). The main content area displays an email titled 'tagihan publikasi JCTM' from 'purkan purkan' (purkan@fst.unair.ac.id) dated 'Rab, 9 Agu 2017 08.41'. The email body contains the following text:

Bapak ibu author Yth,

Untuk penerbitan artikel bapak ibu di Journal of Chemical Technology and Metallurgy, maka setiap manuscript dikenakan biaya 150\$. kami harus menyelesaikan awal september. Sementara kami mengestimai nilai kurs 1\$ = Rp. 14.000. sehingga total charge per naskah adalah Rp 2.100.000,- Sekiranya nanti nilai setoran bapak ibu ada kelebihan dari yang kami kirim ke editor JCTM, akan kami kembalikan ke bapak ibu via transfer juga.

Untuk ini, penampungan, mohon biaya dikirim paling lambat tgl 21 Agustus 2017 ke Sekretaris Departemen Kimia berikut :

Rekening bank Mandiri :
Atas Nama: Abdulloh
Nomor Rekening : 141-0009850306

Mohon jika sudah transfer, buktinya dikirim ke email ini. Atas perhatiannya, kami sampaikan terima kasih

Salam
Dr. Purkan, M.Si

BUKTI KORESPONDENSI

The screenshot shows a Gmail interface with a search bar at the top containing "JCTM". The left sidebar lists folders: "Tulis", "Kotak Masuk" (1,637), "Berbintang", "Ditunda", "Penting", "Terkirim", "Draf" (2), "Kategori", "Selengkapnya", "Label" (+), "Junk E-mail", and "UTS kapsel" (1). The main email content is as follows:

7 dari 18 < >

OKE for preprints of Harsasi Setyawati's paper >

Harsasi Setyawati <harsasi85@gmail.com>
kepada journal, purkan, purkan ▾

Sab, 23 Sep 2017 09:03 ☆ ↶ ⋮

Dear editor **JCTM**,
Herein I agree with all of preprints that was sent to me. Many thanks.

Harsasi Setyawati

Sent from my iPhone

↶ Balas ↶ Balas ke semua ↷ Teruskan

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

Department of Chemistry, Faculty of Science and Technology
Airlangga University, 60115 Indonesia
E-mail: harsasi85@gmail.com

Received 05 January 2017
Accepted 20 July 2017

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 ($\text{Ti}(\text{OC}_3\text{H}_7)_4$) (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 ($\text{CH}_2\text{CH}_3\text{OH}$) 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

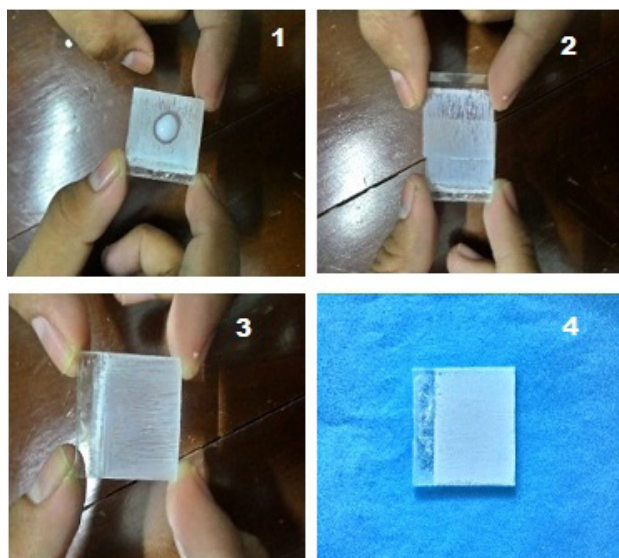


Fig. 1. Preparation of conductive glass using a simple glass plate and a thin layer of TiO_2 .

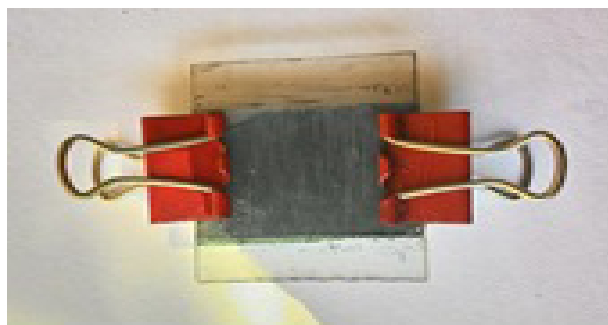


Fig. 2. DSSC cells.

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.

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).

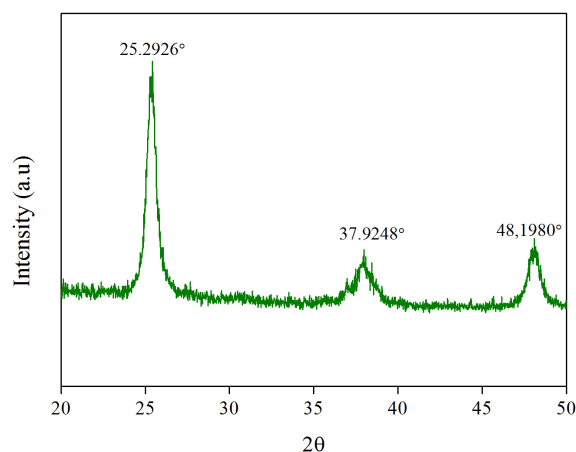


Fig. 3. The diffractogram of TiO_2 thin layer deposited on a simple glass plate.

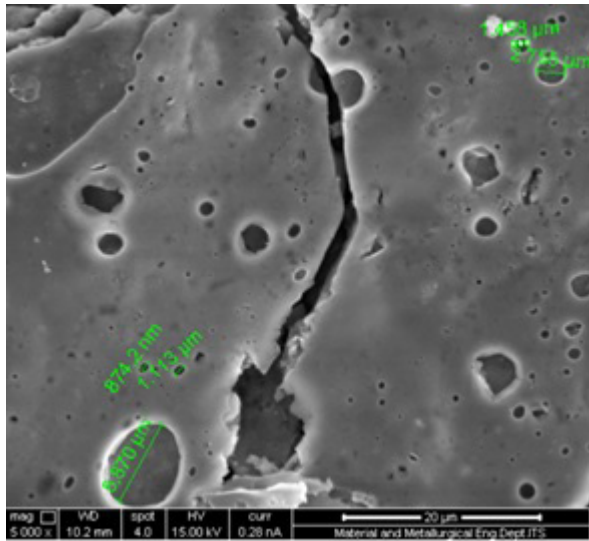


Fig. 4. SEM images of the surface of the thin TiO₂ layer deposited on simple glass plate (zoom 5000x).

It is compared to the diffractogram of anatase TiO₂ on the standard spectrum card JCPDS No. 88-1175 and 84-1286. Anatase TiO₂ has a larger surface area than TiO₂ rutile facilitating dye sensitizer attachment [10].

The thin TiO₂ 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

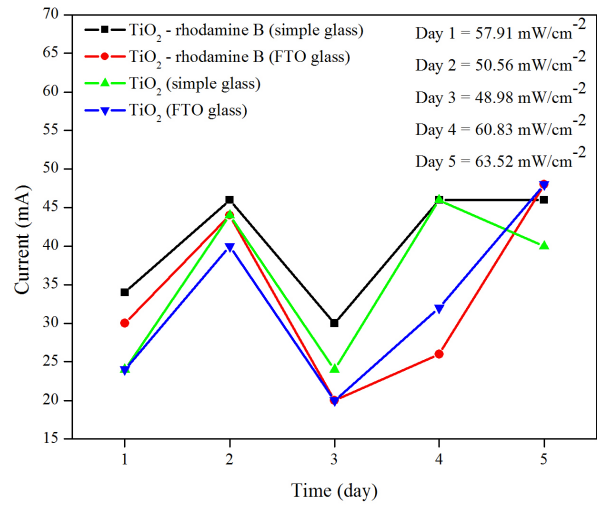


Fig. 5. Current vs time curve.

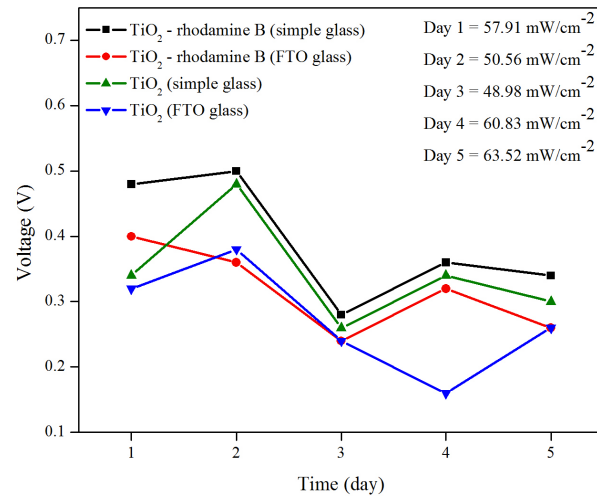


Fig. 6. Voltage vs time curve.

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.

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 TiO₂ and 0.4552 V/0.0064 mA for TiO₂-rhodamine B. The same is valid for the efficiency as well. The values estimated refer to 0.00173 % for TiO₂ and 0.00169 % for TiO₂-rhodamine B. These results verify that the glass obtained through deposition of a thin TiO₂ 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

The authors would acknowledge the research grant "Hibah Dosen Muda" sponsored by Faculty of Science and Technology of Airlangga University. They thank "PUPT (Penelitian Unggulan Perguruan Tinggi)" sponsored by RISTEKDIKTI (Kementerian Riset Teknologi dan Pendidikan Tinggi) for the generous funding and the Department of Chemistry at the Faculty of Science and Technology of Airlangga University Surabaya, Indonesia, for support and facilities.

REFERENCES

1. J. Zhou et al., Effect of Ag Powder and Glass Frit in Ag Paste on Front Contract of Silicon Solar Cells, *Procedia Engineering*, 94, 2014, 1-5.
2. D. Aradilla et al., Properties of nanometric and micro-metric multilayered films made of three conducting polymers, *Eurepean Polymer Journal*, 46, 12, 2010, 2222-2228.
3. A. Jarkov et al., Conductive polymer PEDOT:PSS back contact for CdTe solar cell, *Thin Solid Films*, 519, 21,2011, 7449-7452.
4. S. Jayaraman, D. Rajarathnam, M. Srinivasan, Formation of polythiophene multilayers on solid surfaces by covalent molecular assembly, *Materials Science and Engineering B*, 168, 1, 2010, 45-54.
5. A. Purwanto, H. Widiyandari, A. Jumari, Fabrication of high-performance fluorine doped-tin oxide film using flame-assisted spray deposition, *Thin Solid Films*, 520, 6, 2012, 2092-2095.
6. H. Surahman, Y.K. Krisnandi, J. Gunlazuardi, Preparation and Characterization of Transparent Conductive SnO 2-F Thin Film Deposited by Spray Pyrolysis: Relationship between Loading Level and Some Physical Properties, *Procedia Environmental Sciences*, 28, 2015, 242-251.
7. N. Fagnern et al., Effect of titanium tetraisopropoxide concentration on the photocatalytic efficiency of nanocrystalline thin films TiO₂ used for the photodegradation of textile dyes, *Journal of Physics and Chamistry of Solids*, 73, 12, 2012, 1483-1486.
8. R. Vijayalakshmi, V. Rajendran, Synthesis and characterization of nano-TiO₂ via different methods, *Arch. App.Sci.Res.*, 4, 2, 2012, 1183-1190.
9. H. Chang et al., Dye-sensitized solar cell using natural dyes extracted from spinach and ipomoea, *Journal of Alloys and Compounds*, 495, 2, 2010, 606-610.
10. C.M. Malengreaux et al., optimized deposition of TiO₂ thin films produced by a non-aqueous sol-gel method and quantification of their photocatalytic activity, *Chem. Eng. J.*, 195, 2012, 347-358.
11. H. Setyawati et al., Promising Dye Sensitizer on Solar Cell from Complexes of Metal and Rhodamine B, *Int. J. of Renewable Energy Research*, 5, 3, 2015, 694-698.