ELMINA 2022

SECOND INTERNATIONAL CONFERENCE ON ELECTRON MICROSCOPY OF NANOSTRUCTURES

ДРУГА МЕЂУНАРОДНА КОНФЕРЕНЦИЈА О ЕЛЕКТРОНСКОЈ МИКРОСКОПИЈИ НАНОСТРУКТУРА

August 22nd–26th, 2022, Belgrade, Serbia
22–26. август 2022. Београд, Србија

SECOND INTERNATIONAL CONFERENCE

ELMINA 2022

Serbian Academy of Sciences and Arts, Belgrade, Serbia
August 22nd-26th, 2022
http://elmina.tmf.bg.ac.rs

Program and Book of Abstracts

Organized by:
Serbian Academy of Sciences and Arts
and
Faculty of Technology and Metallurgy, University of Belgrade

Endorsed by:
European Microscopy Society
and
Federation of European Materials Societies

Title: SECOND INTERNATIONAL CONFERENCE
ELMINA 2022
Program and Book of Abstracts

Publisher: Serbian Academy of Sciences and Arts
Knez Mihailova 35, 11000 Belgrade, Serbia
Phone: +381 11 2027200
https://www.sanu.ac.rs/en/

Editors: Velimir R. Radmilović and Vuk V. Radmilović

Technical Editor: Vuk V. Radmilović

Cover page: Raša Hindawi

Printed in: Serbian Academy of Sciences and Arts
Knez Mihailova 35, 11000 Belgrade, Serbia
Phone: +381 11 2027128
stamparija@sanu.ac.rs
Circulation: 55 copies.

Improving the contact surface between TiO_2 nanotubes and $MAPbBr_3$ to make perovskite solar cells

Milica Stefanović[1], Ivana Lukić[2], Jelena Vujančević[3], Rada Petrović[2] and Đorđe Janaćković[2]

1 Innovation Center of Faculty of Technology and Metallurgy, Ltd, Belgrade, Serbia

2 University of Belgrade, Faculty of Technology and Metallurgy, Belgrade, Serbia

3 Institute of Technical Sciences of SASA, 11000, Belgrade, Serbia

The organo-inorganic perovskites are extraordinary materials that have recently revolutionized the field of photovoltaics due to their low-cost fabrication and high optical absorption. In a short period, they reached great efficiency. Many parameters which affect the quality of perovskite films can be optimized, so the efficiency of these devices can be further improved [1]. In perovskite solar cells, the perovskite layer is an active layer that absorbs the visible part of the spectrum, resulting in the formation of the electron-hole pair. To decrease the recombination of charge carriers, the construction of solar cells requires the existence of two additional layers in order to separate the holes and electrons. TiO_2 could be used as an electron transport layer because its conduction band (CB) lies under the CB of perovskite [2]. In that way, electrons diffuse from CB of perovskite to CB of TiO_2. For these experiments, TiO_2 nanotubular structure provides a one-dimensional transmission channel for the charge carriers, which resulting in faster carrier transport. Perovskite methylammonium lead bromide ($MAPbBr_3$) was coupled with TiO_2 nanotube arrays which were synthesized by anodization of Ti foil and annealed at 450 °C [3]. The most used methods for deposition of perovskite materials on mesoporous and planar TiO_2 are: one-step deposition, two-step sequential deposition, and vapor-assisted solution processing. Disadvantage of these methods is a small contact area between TiO_2 and perovskite [4,5]. The aim of this research was to increase the contact surface of the perovskite and TiO_2 nanotubes by filling the nanotubes with the perovskite material in order to improve electron transport. Due to that, two different methods were used for deposition of $MAPbBr_3$ crystals onto TiO_2 nanotubes: high vacuum assisted with nitrogen gas and application of the supercritical CO_2 as a cosolvent. The procedure of deposition of perovskite in a high vacuum system included degassation of the sample under a high vacuum for 3 h at 200 °C, cooling down the sample, and putting a solution of $MAPbBr_3$ in dimethylformamide (DMF) onto the sample, and then treating with inert gas (N_2), which enabled the filling of the nanotubes with perovskite material to some extent [6]. Deposition of solution perovskite on TiO_2 nanotubes assisted by supercritical carbon dioxide was done at 200 bar and 35 °C for 1 h. The supercritical fluid, CO_2 had a role of a cosolvent which would help the filling nanotubes with perovskite material. XRD analysis of synthesized perovskite confirms coincidence with literature data [6]. Morphological characterization of samples after deposition of perovskite was carried out by FESEM. It was observed that the filling of nanotubes is better when deposition of perovskite was assisted by supercritical CO_2. The measurement of the *I-V* characteristic under visible light shows that the value of current for this sample is also higher, so it could be concluded that a better contact between perovskite and TiO_2 nanotubes was achieved in this case. Perovskite photodiodes that were made in this study will be the basis for future solar cell construction.

References:

[1] Q. Chen *et al*, Nano Today **10** (2015), pp 355.
[2] N. Marinova, S. Valero, J.L. Delgado, Journal of Colloid and Interface Science **488** (2017), pp. 373.

[3] E. Marchezini *et al*, Materials Research Express **7** (2020), pp. 025017.
[4] U. Mehmood *et al*, Renewable and Sustainable Energy Reviews **78** (2017), pp. 1.
[5] J. Vujančević *et al*, Ceramics International **45** (2019), pp.10013.
[6] M. Stefanović *et al*, Tehnika **77** (2022), pp. 15.
[7] The authors acknowledge funding from the Ministry of Education, Science and Technological Development of the Republic of Serbia Contact No. 451-03-68/2022-14/200287, 451-03-68/2022-14/200135 and 451-03-68/2022-14/200175.

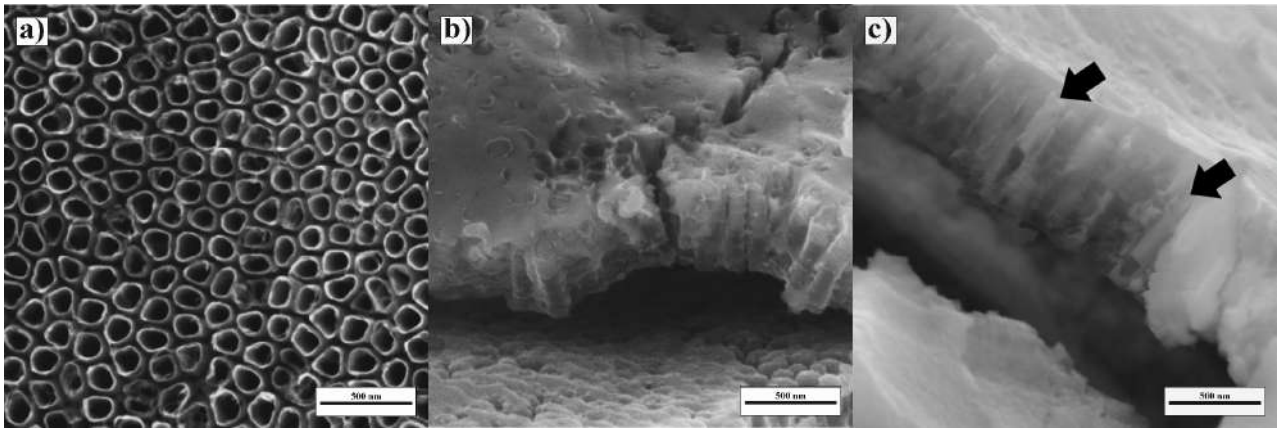

Figure 1. FESEM micrographs of a) pristine TiO_2 nanotube arrays, and TiO_2 nanotube arrays with $MAPbBr_3$ perovskite deposited b) in a high vacuum and inert gas [6] and c) assisted by supercritical CO_2 (the black arrow shows that the TiO_2 nanotubes are more filled with perovskite compared to the sample under b).

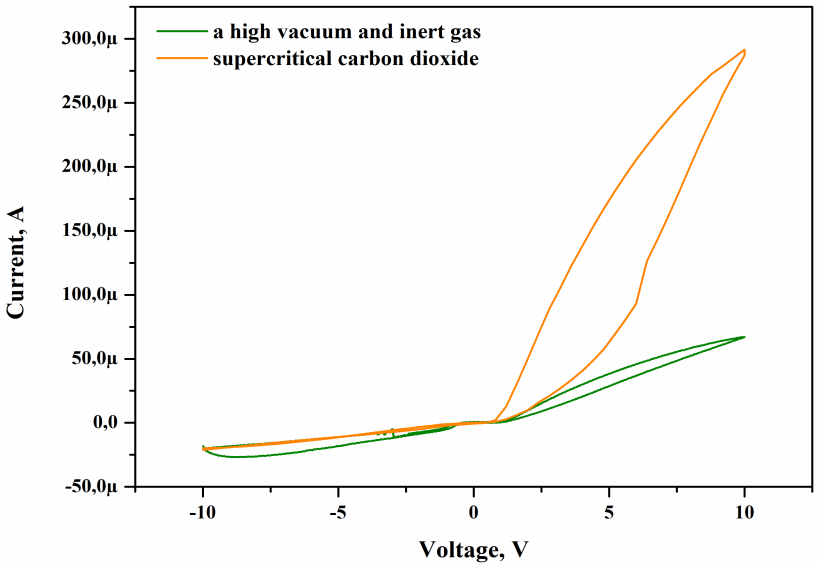

Figure 2. *I-V* characteristics of TiO_2 nanotubes-$MAPbBr_3$ perovskite photodiodes after preconditioning (poling at 10 V for 30 s) with external bias voltage under visible light. Hysteresis curves were obtained for both samples, but the value of current was higher for the sample which was done with supercritical CO_2. It supposes that one of the reasons is a larger contact surface between TiO_2 nanotubes and $MAPbBr_3$ perovskite.

CIP – Каталогизација у публикацији
Народна библиотека Србије, Београд

66.017/.018(048)
544.2(048)
621.385.833.2(048)

INTERNATIONAL Conference on Electron Microscopy of Nanostructures ELMINA (2 ; 2022 ; Beograd)
Program ; & Book of Abstracts / Second International Conference ELMINA [Electron Microscopy of Nanostructures] 2022, Belgrade, Serbia, August 22nd-26th, 2022 ; organized by Serbian Academy of Sciences and Arts and University of Belgrade, Faculty of Technology and Metallurgy ; [editors Velimir R. Radmilović and Vuk V. Radmilović]. - Belgrade : SASA, 2022 (Belgrade : SASA). - 223 str. : ilustr. ; 30 cm

Na nasl. str.: European Microscopy Society and Federation of European Materials Societies. - Tiraž 55. - Bibliografija uz svaki apstrakt. - Registar.

ISBN 978-86-7025-943-0

а) Наука о материјалима -- Апстракти б) Нанотехнологија -- Апстракти в) Електронска микроскопија -- Апстракти

COBISS.SR-ID 72022025