Contribution ID: **102** Type: **Poster Presentation**

Development of TiO_2 nanotube arrays with a modified energy band gap for hydrogen evolution

Tuesday, 4 July 2023 15:57 (1 minute)

Arnold Mutubuki[1], Nyasha Joseph Suliali[2] and Johannes Reinhardt Botha[1]
1 Physics Department, Nelson Mandela University, P.O. Box 77000, Gqeberha 6031, South Africa
2 School of Physics, Engineering and Technology University of York, Heslington, York YO10 5DD, United Kingdom
Corresponding author email address: s226046524@mandela.ac.za

Photoelectrochemical water splitting (PECWS) for hydrogen evolution through solar exploitation is a potential alternative way of harnessing energy [1]. TiO_2 is a well-known photocatalyst with exceptionally reliable chemical properties [1]. Highly ordered TiO_2 nanotube arrays prepared by electrochemical anodization have widely been used as photocatalysts due to their unique structure, large specific area, and fast unidirectional charge transfer [1,2]. Pristine TiO_2 has a band gap energy of 3.0 – 3.2 eV, making the material inefficient as a photoelectrode in PECWS, since absorption is limited to the UV region of the electromagnetic spectrum. Narrowing the band gap energy consequently extends its absorption into the visible region, which improves the photocurrent density [2,3].
In this work, the envisaged surface modified TiO_2 photoelectrodes are fabricated through a multi-step electrochemical anodization process. The final anodization step detaches the crystalline TiO_2 nanotube film from the opaque titanium substrate. Thereafter, the film is transferred and pasted onto transparent fluorine-doped tin oxide (FTO) glass. Surface modifications of the nanostructured thin film are achieved through successive ionic layer adsorption reaction (SILAR) to deposit nanostructured metal oxides. The synthesized samples are characterized by X-ray diffraction, SEM, EDS, TEM and UV-Visible spectroscopy.
The results confirm the impregnation of TiO_2 by copper oxide nanoparticles. The optical characterization indicates a red shift in the absorption edge of the CuO/TiO_2 towards the visible light range. The effect of the number of SILAR cycles on the absorption edge has also been investigated in this study. The structural characterization reveals that the loading of CuO on the CuO/TiO_2 nanotubes does not alter the morphology of the nanotubes.
This work demonstrates a facile method to prepare TiO_2 nanostructured heterojunction thin films on a transparent substrate, which could be a promising photoelectrode.
Future work includes optimizing the fabrication process of the photoelectrodes, optical and electrochemical characterization and thereafter, PECWS experiments and hydrogen evolution efficiency measurements.

Key words: TiO_2 nanotube arrays, CuO nanoparticles, SILAR, heterojunction, photoelectrode.

References

1. Lixia, S., Jing, Z., Yudong, Z. & Yangbo, Z., 2015. Preparation of CuO/TiO_2 nanotube arrays and their photoelectrochemical properties as hydrogen-evolving photoanode. Solar Hydrogen and Nanotechnology.
2. Loı¨, A., Vasile, H., Margrit, H. & ken, L. S., 2013. Cu_2O, Fabrication of p/n heterojunctions by electrochemical deposition of onto TiO_2 nanotubes. Comptes Rendus Chimie, p. 89 -95.
3. Marica, M., Roberto, A., Laura, C. & Ilaria, D. S., 2020. Hydrogen production through photoreforming processes over CuO/TiO_2 composite materials: A mini-review. International Journal of Hydrogen Energy, Issue 45, p. 28531-28552.

Apply to be considered for a student ; award (Yes / No)?

yes

Level for award;(Hons, MSc, PhD, N/A)?

MSc

Primary author: MUTUBUKI, Arnold (Nelson Mandela University)

Presenter: MUTUBUKI, Arnold (Nelson Mandela University)

Session Classification: Poster Session 1

Track Classification: Track A - Physics of Condensed Matter and Materials