PURSE 2021

PERADENIYA UNIVERSITY INTERNATIONAL RESEARCH SESSIONS

Research and Innovation for an Inclusive Society

PROCEEDINGS

Peradeniya University International Research Sessions 2021

Volume 23

11 and 12 November 2021

UNIVERSITY OF PERADENIYA

SRI LANKA

"Research and Innovation for an Inclusive Society"

PROCEEDINGS

PERADENIYA UNIVERSITY INTERNATIONAL RESEARCH SESSIONS (*i*PURSE) 2021

Volume 23

11th & 12th November 2021

Hosted by

Faculty of Arts
University of Peradeniya
Sri Lanka

Application of Low-Cost Graphite Counter Electrode for Dye-Sensitized Solar Cells: A Comparative Study on Sintering Temperature

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In dye sensitized solar cells (DSSCs), a thin film of platinum (Pt) is extensively used as the catalytic material on the counter electrode (CE) due to its higher conductivity and electro-catalytic activity. However, there is a considerable effort to replace Pt CEs due to high cost and limited supply of Pt. In order to replace Pt CEs with low cost materials with high electronic conductivity and comparable catalytic effects for tri-iodide reduction, various alternative materials have been investigated. In this study, Sri Lankan natural vein graphite is used to fabricate low cost CEs for DSSCs. Sri Lankan natural vein graphite has become more attractive and demanding in the world due to its high purity and high crystallinity. In order to improve the adhesion of vein graphite on conducting glass substrate, Polyvinylidene fluoride (PVDF) polymer was used as a binder. To investigate the effect of sintering temperature on the performance of CEs, a series of graphite CEs were prepared with different sintering temperatures ranging from 150 ^{o}C to 550 ^{o}C. Results confirmed that the DSSCs prepared with sintered CEs exhibit a better photovoltaic performance compared to the DSSCs made with un-sintered CEs. DSSCs with CEs sintered at 450 ^{o}C have exhibited the highest efficiency of 4.45 % with an overall efficiency increase of 158% compared to un-sintered CEs (η = 1.72%). DSSCs fabricated with the graphite CEs prepared either with sintering at temperatures below 450 ^{o}C or above 450 ^{o}C showed poor performance possibly due to the presence of more undecomposed binder at lower temperatures and residual burnt particles left over at higher temperatures in the CEs. This low cost and novel graphite CE exhibits good stability and acceptable solar cell efficiency of close to 60% of that of Pt (η = 7.82%) CE in DSSCs operating under similar conditions.

Keywords: Dye-sensitized solar cells, Counter electrode, Graphite, Sintering temperature

Financial assistance from National Science Foundation of Sri Lanka is gratefully acknowledged (Grant No: NSF-PSF/ICRP/2017/EA&ICT/04).