JOURNAL OF ENERGY CHEMISTRY
http://www.journals.elsevier.com/journal-of-energy-chemistry/

Analysis of silicon-based integrated photovoltaic-electrochemical hydrogen generation system under varying temperature and illumination

Vishwa Bhatt , Brijesh Tripathi , Pankaj Yadav , Manoj Kumar

PII: S2095-4956(16)30193-0
DOI: 10.1016/j.jechem.2016.09.006
Reference: JECHEM 195

To appear in: *Journal of Energy Chemistry*

Received date: 31 May 2016
Revised date: 29 July 2016
Accepted date: 2 September 2016

Analysis of silicon-based integrated photovoltaic-electrochemical hydrogen generation system under varying temperature and illumination

Vishwa Bhatt[a], Brijesh Tripathi[b], Pankaj Yadav[c], Manoj Kumar[b,*]

[a]*Department of Solar Energy, School of Technology, Pandit Deendayal Petroleum University, Gandhinagar-382007, India*

[b]*Department of Science, School of Technology, Pandit Deendayal Petroleum University, Gandhinagar-382007 India*

[c]*Department of Electrical Engineering, Incheon National University, Incheon-406772 Korea*

Article history:
Received 31 May 2016
Revised 29 July 2016
Accepted 2 September 2016
Available online

Abstract

Last decade witnessed tremendous research and development in the area of photo-electrolytic hydrogen generation using chemically stable nanostructured photo-cathode/anode materials. Due to intimately coupled charge separation and photo-catalytic processes, it is very difficult to optimize individual components of such system leading to a very low demonstrated solar-to-fuel efficiency (SFE) of less than 1%. Recently there has been growing interest in an integrated photovoltaic-electrochemical (PV-EC) system based on GaAs solar cells with the demonstrated SFE of 24.5% under concentrated illumination condition. But a high cost of GaAs based solar cells and recent price drop of poly-crystalline silicon (pc-Si) solar cells motivated researchers to explore silicon based integrated PV-EC system. In this article a theoretical framework is introduced to model silicon-based integrated PV-EC device. The theoretical framework is used to analyze the coupling and kinetic losses of a silicon solar cell based integrated PV-EC water splitting system under varying temperature and illumination. The kinetic loss occurs in the range of 19.1%–27.9% and coupling loss takes place in the range of 5.45%–6.74% with respect to varying illumination in the range of 20–100 mW/cm^2. Similarly, the effect of varying temperature has severe impact on the performance of the system, wherein the coupling loss occurs in the range of 0.84%–21.51% for the temperature variation from 25 to 50 ^{o}C.

Key words: Polycrystalline silicon; Electrochemical cell; Electrochemical impedance spectroscopy; Integrated PV-EC system