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Effect of temperature on the stability of nickel sulfide reduced graphene oxide nanocomposite counter electrode in quantum dot-sensitized solar cells

By [Kharboot, LH](#) (Kharboot, Layla Haythoor) ^{[1], [2]}; [Najib, ASM](#) (Najib, Abdillah Sani Mohd) ^{[1], [3]}; [Bakar, TAA](#) (Bakar, Tuty Asma Abu) ^{[1], [3]}; [Nordin, NH](#) (Nordin, Norhuda Hidayah) ^[4]; [Putra, AEE](#) (Putra, Andi Erwin Eka) ^[5]; [Altaf, AA](#) (Altaf, Ataf Ali) ^[6]; [Fadil, NA](#) (Fadil, Nor Akmal) ^{[1], [3]}

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Abstract Quantum dot-sensitized solar cells (QDSSCs) are equipped with counter electrodes (CEs) based on reduced graphene oxide (rGO) and nickel sulfide (NiS/rGO). A hydrothermal method performed at 150 degrees C with variable reaction times (5, 10, and 15 h) was used to synthesize NiS/rGO CEs and evaluate their electrocatalytic activity and stability by exposing them to varying conditions at 25, 40, 60, and 80 degrees C for 100 h. Electrochemical performance was assessed through cyclic voltammetry (CV), electrochemical impedance spectroscopy (EIS), and Tafel polarization. Results showed that NiS/rGO 5 h exhibited superior electrocatalytic activity, achieving a significantly higher current density. CV results showed that NiS/rGO 5 h generated the highest current density of 112.4 mA/cm² at 80 degrees C ($P_t = 8.1 \text{ mA/cm}^2$), and lower charge-transfer resistance (R_{ct} values, 3.6 $\Omega \text{ cm}^2$ at 80 degrees C than ($P_t = 674.4 \Omega \text{ cm}^2$). The high performance was attributed to the dominance of beta-NiS phase. Additionally, the nanocomposites demonstrated strong mechanical adhesion and stability under prolonged exposure to elevated temperatures. This study highlights the potential of NiS/rGO nanocomposites as cost-effective and efficient alternatives to Pt for improved QDSSC performance.

Keywords **Keywords Plus:** PHOTOVOLTAIC PERFORMANCE; LOW-COST; EFFICIENCY; COMPOSITE; ARRAYS

Author Information Corresponding Address: Fadil, Nor Akmal (corresponding author)

▼ Univ Teknol Malaysia, Fac Mech Engn, Dept Mat Mfg & Ind Engn, Johor Baharu 81310, Johor, Malaysia

Corresponding Address: Fadil, Nor Akmal (corresponding author)

▼ Univ Teknol Malaysia, Fac Mech Engn, Mat Res & Consultancy Grp, Johor Baharu 81310, Johor, Malaysia

E-mail Addresses :

norakmal@utm.my

Addresses :

- ▼ ¹ Univ Teknol Malaysia, Fac Mech Engn, Dept Mat Mfg & Ind Engn, Johor Baharu 81310, Johor, Malaysia
- ▼ ² Univ Al Hussain Coll, Dept Renewable Energy Engn, Karbala, Iraq
- ▼ ³ Univ Teknol Malaysia, Fac Mech Engn, Mat Res & Consultancy Grp, Johor Baharu 81310, Johor, Malaysia
- ▼ ⁴ Int Islamic Univ Malaysia, Dept Mfg & Mat Engn, Jalan Gombak, Kuala Lumpur 53100, Selangor, Malaysia
- ▼ ⁵ Hasanuddin Univ, Waste Energy Res Grp, Makassar 90245, Indonesia

[...more addresses](#)

E-mail Addresses :

norakmal@utm.my

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