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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

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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 °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 °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/cm<sup>2</sup> at 80 °C (Pt = 8.1 mA/cm<sup>2</sup>), and lower charge-transfer resistance ( $R_{ct}$  values, 3.6  $\Omega$  cm<sup>2</sup> at 80 °C than (Pt = 674.4  $\Omega$  cm<sup>2</sup>). 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. © The Author(s) 2026.

## Indexed keywords

### Engineering controlled terms

Cost effectiveness; Electrochemical electrodes; Electrochemical impedance spectroscopy; Graphene; Nanocrystals; Nickel; Nickel oxide; Nickel sulfates; Reduced Graphene Oxide; Sulfur compounds

### Engineering uncontrolled terms

Cell/B.E; Counter electrodes; Effects of temperature; Graphene oxide nanocomposites; High current densities; Nickel sulphide; Quantum dot-sensitized solar cells; Quantum dots-sensitized solar cells; Quantum-dot-sensitized solar cells; Reduced graphene oxides

### Engineering main heading

Cyclic voltammetry

## Funding details

Details about financial support for research, including funding sources and grant numbers as provided in academic publications.

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Ministry of Higher Education, Malaysia <a href="#">See opportunities by MOHE</a> ↗		MOHE
Universiti Teknologi Malaysia <a href="#">See opportunities by UTM</a> ↗	Q.J130000.3824.23H15	UTM
Universiti Teknologi Malaysia <a href="#">See opportunities by UTM</a> ↗		UTM
UTMUNHAS	Q.J130000.3024.04M95	

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Abstract

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