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Investigating the Impact of Electrolyte Temperature on the Oxygen Evolution Reaction Efficiency of Ni-Co/NiFelt Nano Composite Electrode

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Abstract

This study investigates the impact of electrolyte temperature on the electrochemical behavior of Ni-Co nanocomposite electrodes supported by NiFelt in an alkaline water electrolyzer setup. Using a three-electrode configuration, the effects of temperature variations (20-80°C) on electrocatalyst stability and reaction kinetics were evaluated. Results indicate higher temperatures enhance OER kinetics but compromise reaction stability due to increased conductivity and active sites. This research underscores the importance of optimizing electrolyte temperature for industrial AWE applications.

Keywords: Ni-Co/Nifelt, electrocatalyst, water electrolysis, temperature effect, nanocomposite

Introduction

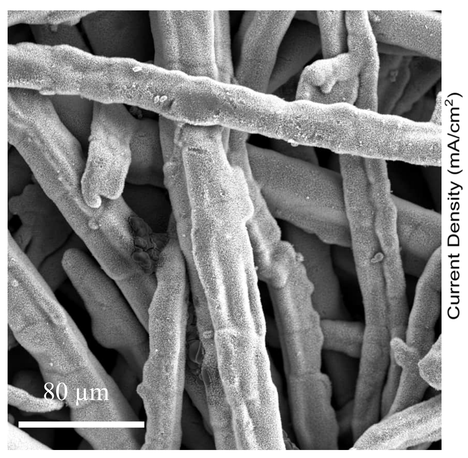
Alkaline water electrolysis (AWE) emerged as a viable alternative for producing eco-friendly hydrogen and has been a cornerstone in industrial hydrogen generation particularly through non-noble electrocatalysts [1-3]. To this end, a nanocomposite of Ni-Co is synthesized with the hydrothermal method followed by calcination and used as a binder-free method to coat this electrocatalyst onto the NiFelt as gas diffusion layer (GDL) [4]. The investigation used a standard three-electrode setup, employing Pt wire as the counter electrode, Ag/AgCl as the reference electrode, and a self-made Ni-Co/NiFelt nanocomposite electrode as the working electrode. Temperatures ranging from 20 to 80°C were tested to identify the optimal temperature ensuring electrocatalyst stability.

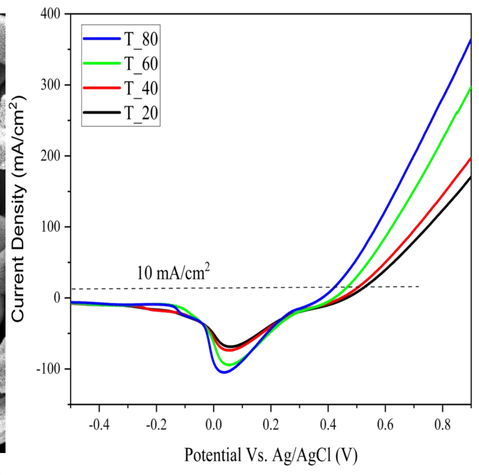
Experimental

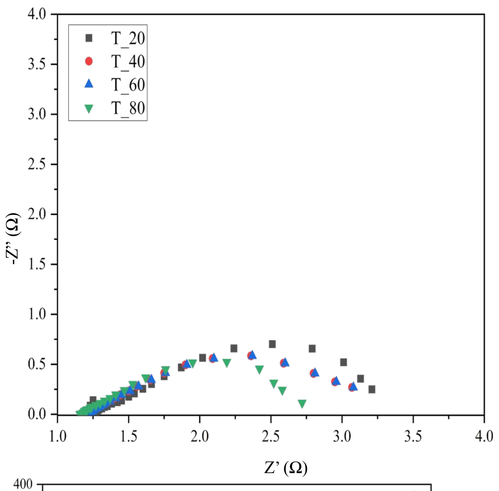
- $NiCl_2 \cdot 6H_2O$ and $CoCl_2 \cdot 6H_2O$ were separately dissolved in DI water, then mixed and stirred. (A)
- Ultrasonicate the mixture (A) plus Hydrolysis with Urea
- Hydrothermal reaction in Teflon autoclave at 120°C-10 hr
- Calcination at 420 °C for 3hr

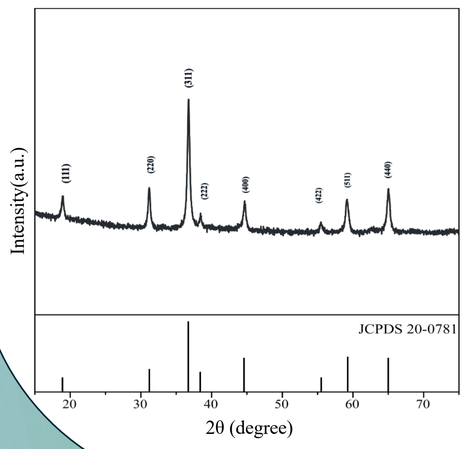
Results & Discussion

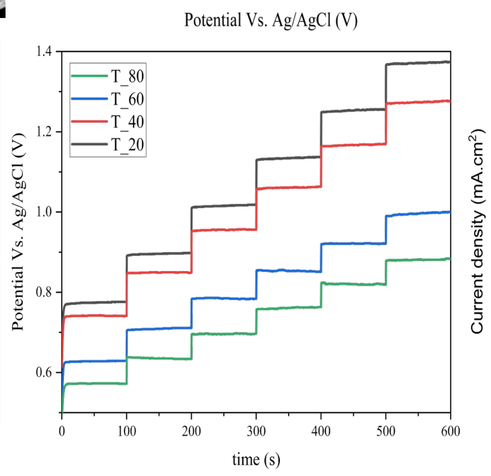
- XRD confirms the presence of pure $NiCo_2O_4$ powder compared to JCPDS No 20-0781.
- SEM reveals the flower-like structure and nanorod growth of the Ni-Co transient electrocatalyst on the NiFelt surface.
- Higher potential for Linear sweep Voltammetry (LSV) was achieved at 80°C (410 mV Vs. Ag/AgCl), followed by 60°C (430 mV) without iR compensation.
- Charge transfer resistance decreased with increasing temperature, from 1.97 Ω at 20°C to 1.5 Ω at 80°C (24% lower).
- Fluctuations were observed at 80°C during stability tests, potentially leading to degradation or leaching of the active phase.
- Stability was maintained at 60°C, with only a 20 mV difference compared to 80°C at 10 mA/cm².

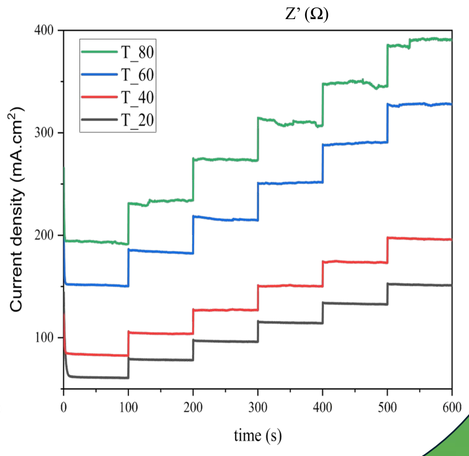






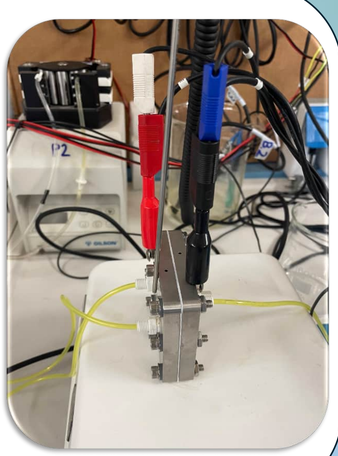






Conclusion

The synthesized Ni-Co/NiFelt Nano Composite exhibited promising potential versus Ag/AgCl electrodes in alkaline electrolyte, with values of 430 mV at 60°C and 410 mV at 80°C. While it showed higher performance and lower resistance at 80°C, it demonstrated better stability and performance at 60°C. These findings suggest potential for utilizing this electrode as an anode in anion exchange membrane water electrolysis (AEMWE) systems.



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