Unveiling the Optimal Synergy of the passivation temperature of Ni-based anodes towards facial electrochemical water splitting

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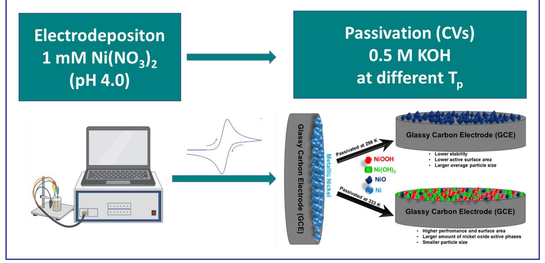
KAUST Research Conference: Hydrogen-Based Mobility and Power

Introduction

- The long term emission consequences of fossil fuel combustion posed a clear motivation towards the development of sustainable energy systems.
- Hydrogen is an ideal chemical energy carrier that does not exist in its pure state in nature, and has to be produced from hydrogen-containing resources such water.
- Water splitting provides a clean, efficient and portable hydrogen fuel for fuel cells, which are now of great interest.
- The oxygen evolution reaction (OER) suffers from the inefficiency of the oxidation process.
- In this regard, Ni-based catalysts have shown promise activity towards the OER, meanwhile, their stability and the activity are crucial parameters that gained a lot of interest recently.
- **Herein,** the effect of the passivation temperature (T_p) of nickel oxide nanostructures modified glassy carbon (nano-NiO_x/GC) electrode on the electrocatalytic activity towards the OER has been addressed.

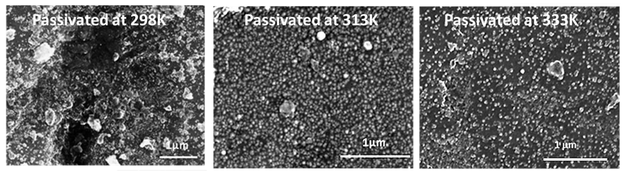
Methodology

Synthesis of nano-NiO_x/GC

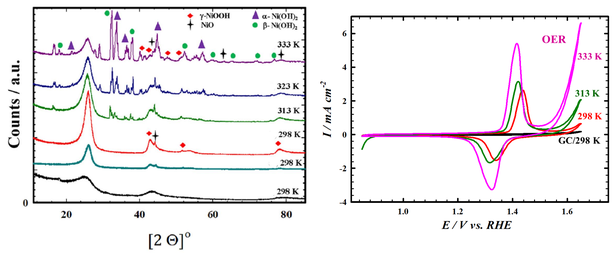


Material characterization

SEM

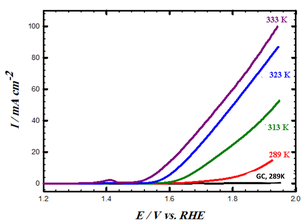


XRD and CVs



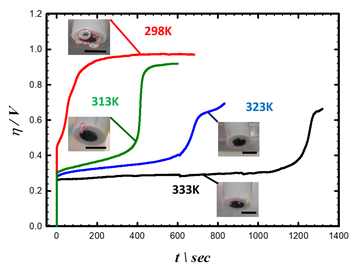
Results

LSVs (OER)

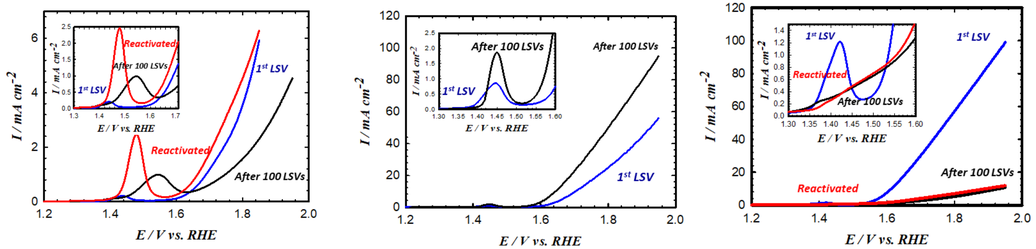


T_p=T_m / K	E_{10} / V vs RHE
298	1.88
313	1.69
323	1.62
333	1.57

Chronopotentiometry (E-t) recorded at 7mA cm^{-2} at different T_m (long term stability test) and photo images of bubble size at the surface of NiO_x/GC electrodes



Activation /deactivation behavior



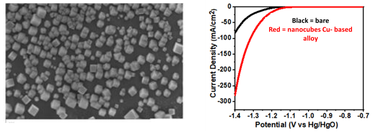
Inspection of this figure reflects several interesting points:
(1) Increasing T_p from 298 to 323 K, increases I_{OER}. (2) The electrodes passivated at 323 K show the highest activity towards the OER compared with the others passivated at 298, 313 or 333 K. (3) Cycling the potential several times between 0.85 and 1.65 V vs. RHE restores the activity to various extents depending on the measurement temperature (Tm). (4) Moreover, reactivation by cycling in the potential range of 0.85e1.65 V vs. RHE did not retrieve the Ni^{2+}/Ni^{3+} anodic peak and the activity towards the OER.

Summary

- The morphology and relative population of the active phases of electrodeposited nano-NiO_x on GC electrode is found to be correlated with the passivation temperature (T_p).
- Increasing T_p resulted in decreasing the particle size and hence increases the concentration of the electroactive surface species of NiO_x. This was revealed from the favorable negative potential shift of E_{onset} of the OER and the higher exchange current densities at higher T_p, indicating faster kinetics.
- Moreover, performing the OER at a high solution temperature, e.g., 333 K, resulted in higher stability as revealed from the aging experiment.
- Prolonged anodic scans are found to affect the stability of the examined electrodes. Performing the OER at nano-NiO_x/GC electrode in 0.5 M KOH at 323 K is considered as the optimum conditions for stable performance at LSV scans up to 100 times.

Ongoing Work

Cu-based alloy for Hydrogen evolution reaction (HER)



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