

## Investigating the effect of doping $\text{LaCoO}_3$ in $\text{CoFe}_2\text{O}_4$ forming nanocomposite, towards oxygen evolution and methanol oxidation reactions in alkaline medium

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$\text{CoFe}_2\text{O}_4$ - $\text{LaCoO}_3$  was synthesized employing a two-step, low-temperature wet chemical method involving co-precipitation and sol-gel techniques. The co-precipitation process was employed to prepare  $\text{CoFe}_2\text{O}_4$ , with pH regulation at 11 using NaOH solution. Subsequently,  $\text{CoFe}_2\text{O}_4$ - $\text{LaCoO}_3$  was synthesized *via* sol-gel process. The synthesized materials were subjected to physicochemical analysis using Fourier Transform Infrared spectroscopy (FTIR), X-ray diffraction (XRD) and Scanning Electron Microscopy (SEM). The electrocatalytic properties of these materials were evaluated in terms of their performance towards oxygen evolution reaction (OER) and methanol oxidation reaction (MOR) in alkaline medium. The redox behaviour of the materials was characterized through cyclic voltammetry analysis in 1M KOH solution. The electrocatalytic activity of the materials, when assessed using anodic polarization curves revealed that  $\text{CoFe}_2\text{O}_4$ - $\text{LaCoO}_3$  exhibited higher activity, with current densities of  $1.6 \text{ mA cm}^{-2}$  for OER and  $9.2 \text{ mA cm}^{-2}$  for MOR recorded at 650 mV. Further, the thermodynamic parameters like standard enthalpy of activation ( $\Delta H^{\ddagger}$ ), standard entropy of activation ( $\Delta S^{\ddagger}$ ) and standard electrochemical energy of activation ( $\Delta H_{e1}^{\ddagger}$ ) were calculated by recording anodic polarization curve in KOH as well as KOH with  $\text{CH}_3\text{OH}$  solutions at various temperatures. The findings presented in this study demonstrate the promising electrocatalytic performance of  $\text{CoFe}_2\text{O}_4$ - $\text{LaCoO}_3$  film electrode for applications in OER and MOR under alkaline condition.

**Keywords:** Nanocomposite, Sol-gel procedure, XRD, Oxygen evolution reaction, Methanol oxidation reaction