Abstract

Fuel cells have emerged as promising clean energy technologies, offering high energy conversion efficiency and negligible greenhouse gas emissions. One crucial component of many fuel cell types is the hydrogen evolution reaction (HER), which plays a pivotal role in generating electricity through the electrochemical conversion of hydrogen and oxygen into water. Noble metals like platinum, as well as non-precious metal catalysts have been explored to reduce costs and improve accessibility. In the present research work, Pt-rGO composites were synthesized by using different reducing agents, along with this PtCoFe composite nanoparticles were also synthesized as novel materials to check their activity towards HER. Pt-rGO composite shows the best HER performance with $NaBH_4$ reducing agent showing an overpotential of 83 mV at a current density of 10 mA cm^{-2} and a least Tafel slope 86 mV dec^{-1}, and large electrochemical surface area 348.5 cm^2. This composite has demonstrated a least charge transfer resistance compared via Electrochemical Impedance Spectroscopy (EIS), and is stable under controlled potential electrolysis (CPE) for a duration of 6 h. PtCoFe alloy also show an extraordinary performance with an overpotential of 36 mV at a current density of 10 mA cm^{-2}, with a least Tafel slope value of 56 mV dec^{-1}.