Effect of Surfactant on Structural and Electrochemical Properties of Nickel Oxide

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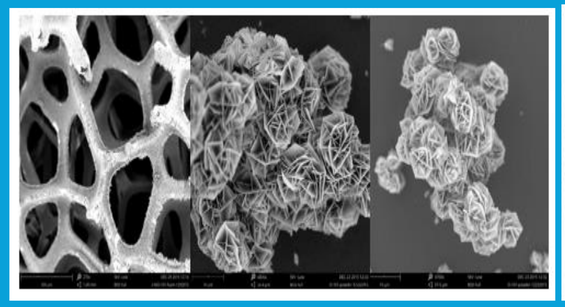
Abstract

The increasing demand for energy in the world led to focus on more efficient energy storage devices. Energy can be stored in various kind of devices such as batteries, capacitors and fuel cells. Among them, supercapacitors are very attractive due to their high power densities, fast charge-discharge behavior and long life cycles. They can be used in hybrid cars and devices where high-power delivery is required. The objective of this work is to study the effect of morphology of nickel oxide on their electrochemical properties. The morphology of nickel oxide was modified using various surfactants. Structural characterization performed using scanning electron microscopy reveals the nanostructure of nickel oxides. The electrochemical properties of nickel oxide were studied using cyclic voltammetry and galvanostatic charge –discharge measurements. A very high specific capacitance of about 315 F/g was observed at 5 mV/s in alkaline electrolyte. It was observed that charge storage capacity depends on morphology of nickel oxide.

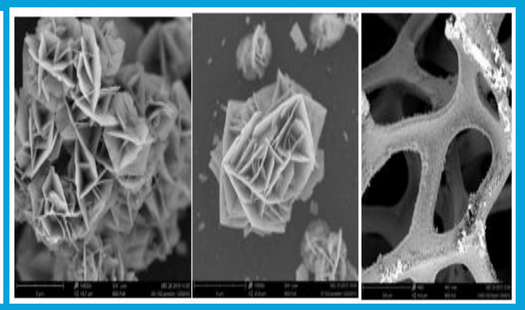
Experimental

All the chemicals and solvents utilized in the experiments were of analytical grade and utilized without further purification .So, The NiO samples were prepared by using 1450 mg of $Ni(NO_3)_2.6H_2O$,1500mg of urea, 400 mg of ammonium fluoride, and 500 mg of surfactants. All three chemicals were dissolved in 33 mL of distilled water. After mixing the reactors with help of bath sonication for 10 minutes, the mixed solution was then transferred into a 45 ml Teflon stainless steel autoclave. Then a piece of nickel foam, which was pre-cleaned and weighted, was immersed into the reaction solution and heated at 120˚ C for 10 h. After 10 h at 120˚ C, the reactors were cooled to room temperature naturally. Then the piece of nickel foam and residue were washed several times with distilled water and absolute ethanol in order to remove the free debris and residual reactant. The obtained material was heated at 500˚ C for 3h to synthesize nickel oxide. The NiO samples prepared by using sodium dodecyl sulfate, cetyltrimethy ammonium bromide, and Polyvinylpyrrolidone surfactants.

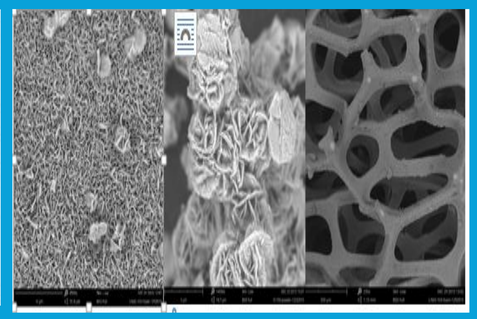
Results and Discussion



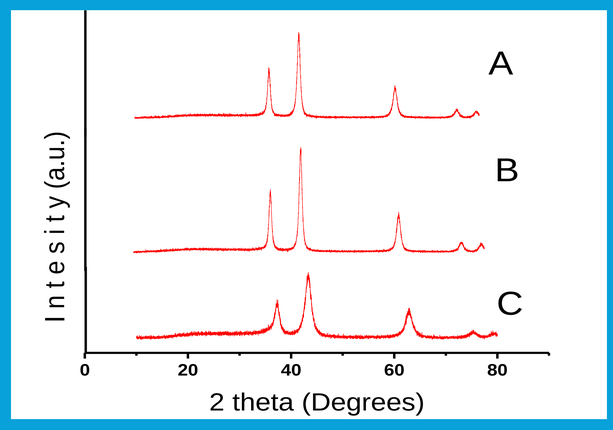
A) SEM images of NiO synthesized using CTAP at various magnifications



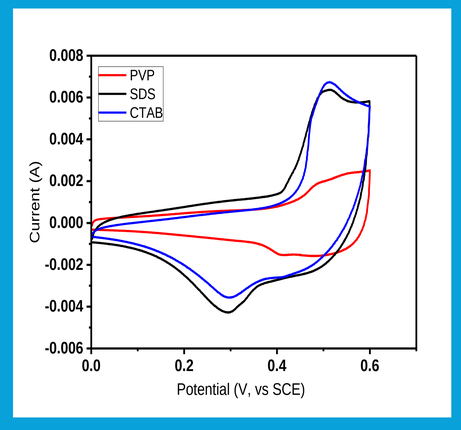
B) SEM images of NiO synthesized using PVP at various magnification



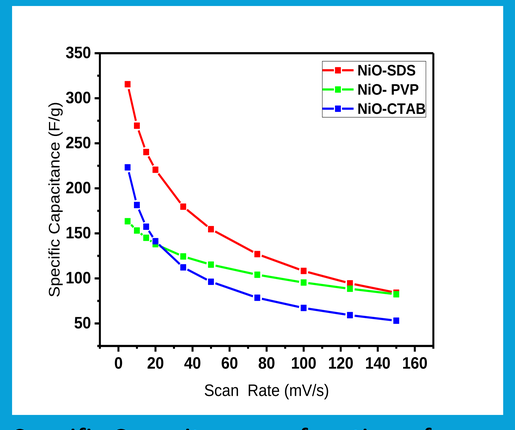
C) SEM images of NiO synthesized using PVP at various magnification



XRD pattern of NiO synthesized using A) SDS, B) CTAB, and C) PVP



CV curve of NiO synthesized using PVP, SDS , and CTAB in 3M LiOH at scan rate 5mV/s.



Specific Capacitance us function of scan rate of NiO in SDS,PVP, and CTAB

Summary

Nickel oxide was synthesized using the hydrothermal technique. Nickel hydroxide has been completely transferred into nickel oxide at 500˚ C, The scanning electron microscopy images showed that three samples of nickel oxide had unique morphology structures and surface areas. The cyclic voltammeter was used to indicate the effects of morphology and surface area on nickel oxide behaviors. the morphological structure of nickel oxide can affect its specific capacitance. The high specific capacitance of nickel oxide as a function of the scan rate was 315 Fg^{-1} which was observed in 3 M LiOH for NiO-SDS at scan rate 5mV/s.