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# Effect of time and temperature on adsorption of persulphate ions for developing 2D nanosheets to 3D microflowers for development of γ nickel hydroxide and its supercapacitor performance

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**Abstract**
In the present investigation, Ni $(OH)_2$ microflowers were successfully deposited on a cost-effective stainless steel electrode by a simple chemical bath deposition method (CBD). The optimized deposition time and heating temperature. Potassium persulphate shows an important role as an oxidizing agent and controlled the growth of nanostructure. Deposited $Ni(OH)_2$ shows α phase but due to persulphate ion one hydrogen removes and it converted into γ phase. The $Ni(OH)_2$ deposited using CBD method at 2 h then heated at 100 °C temperature give better specific capacitance. For a current density of 3.0 mA $cm^{-2}$, the computed highest specific capacitance becomes 669 F $g^{-1}$. After 1000 cycles, electrode material shows good capacitive retention of about 78% and high coulombic efficiency of 99.3%. The impressive results proffered above indicate that $Ni(OH)_2$ is a promising electrode material with excellent supercapacitor performance.

**Keywords** Nickel hydroxide · Microflower · Supercapacitor

## 1 Introduction

As the population grows, the need for energy expands as resources are utilized. Fossil fuels are a conventional energy source that causes pollution that is harmful to the environment. Non-conventional energy sources are non-polluting and non-hazardous to the environment. All non-conventional resources require energy storage systems that have high specific energy, specific power, prolonged life, and compact size due to several constraints [1]. Long-life cycles and high energy density batteries entice buyers, but there are certain drawbacks, such as low power density and higher inner resistance. Recently, a supercapacitor [2] was designed to overcome these difficulties. Amazing properties such as rapid charging and discharging, high power density, superior stability, and long life cycle make supercapacitors a strong contender to batteries. The main impediment to the use of supercapacitors is their low energy density. To improve energy density, preferable research is being pursued all over the world. The electrode material has a significant impact on supercapacitor properties. It categorizes them based on their faradic and non-faradic reaction mechanisms. According to research, ultracapacitors are classified into three types: EDLC, pseudo capacitor, and hybrid supercapacitor [3, 4]. Supercapacitance frequently employs carbon-based materials, metal oxides, metal hydroxides, and polymers. Activated carbon, graphene, ruthenium oxide, manganese oxide, nickel oxide, $Ni(OH)_2$, vanadium pentoxide, and many other materials have been used as electrode materials [5, 6].

$Ni(OH)_2$ is generally utilized as the positive electrode in rechargeable batteries and has outstanding characteristics. The charge storage mechanism in nickel hydroxide involves phase transformation from one phase to another. The characteristics of materials in bulk differ from those in

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