# Hydrothermally synthesis of ytterbium sulfide thin film and its supercapacitor application

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## ABSTRACT

**Ytterbium sulfide thin films are prepared by hydrothermal method. Field emission scanning electron microscopy (FE-SEM) images of ytterbium sulfide films reveal dumb-bell-like shape and porous surface morphology. The film show hydrophilic nature with a contact angle of 40.0°. The ytterbium sulfide film exhibit supercapacitive electrochemical properties in 1 M KOH electrolyte with a capacitance value of 85.00 $Fg^{-1}$ at 5 $mVs^{-1}$ scan rate. The cyclic voltammetry and galvanostatic charge–discharge analyses show that ytterbium sulfide is a potential candidate for anode material with a potential window of - 1 to 0 V/SCE in supercapacitor application.**

**Keywords** : Hydrothermal method, Supercapacitor, Thin films, Ytterbium sulfide.

## INTRODUCTION

Supercapacitors are one of the most important energy storage devices need to be designed with not only high energy density but also high power density [1]. If one thinks of the materials point of view, then there are three families of materials used in supercapacitors. i.e. carbon [2, 3], conducting polymer[4,5] and metal oxide/ sulfide [6, 7].According to literature survey, ytterbium is one of the rare earth metal used in supercapacitors due to its multiple oxidation states. There are lots of reports existing in the deposition of metal sulfide however no reports available on rare earth metal sulfide. Herein, for the first time, present work related to rare earth metal ytterbium sulfide thin film prepared by hydrothermal method and its application in supercapacitor application using 1 M KOH electrolyte. Further, work also includes the morphological, wettability analysis of ytterbium sulfide thin films.

## EXPERIMENTAL :

Ytterbium sulfide thin films were deposited on stainless steel substrate from hydrothermal method in an aqueous medium. The 0.01 M ytterbium trichloride ($YbCl_3$) was dissolved in 20 ml of double-distilled water (DDW) as a source of samarium ions ($Yb^{+3}$). The pH value of the cationic solution ($Yb^{+3}$) was adjusted to 2 ± 0.1 using 0.05 M tartaric acid ($C_4H_6O_6$). For sulfide ion ($S^{-2}$) source, 0.1 M sodium thiosulphate ($Na_2S_2O_3.5H_2O$) was dissolved in 20 ml of DDW. Then, cationic and anionic solutions were mixed together to get 40 ml of volume in a glass beaker. Well-cleaned stainless steel substrates were dipped in the solution and the beaker

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