Thin film Praparation and Characterization of MnO2 by electrodeposition for the application of supercapacitor

Project report submitted to the,

Department of physics

Under the guidance of

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Presented by

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In the year

2018_2019

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ABSTRACT

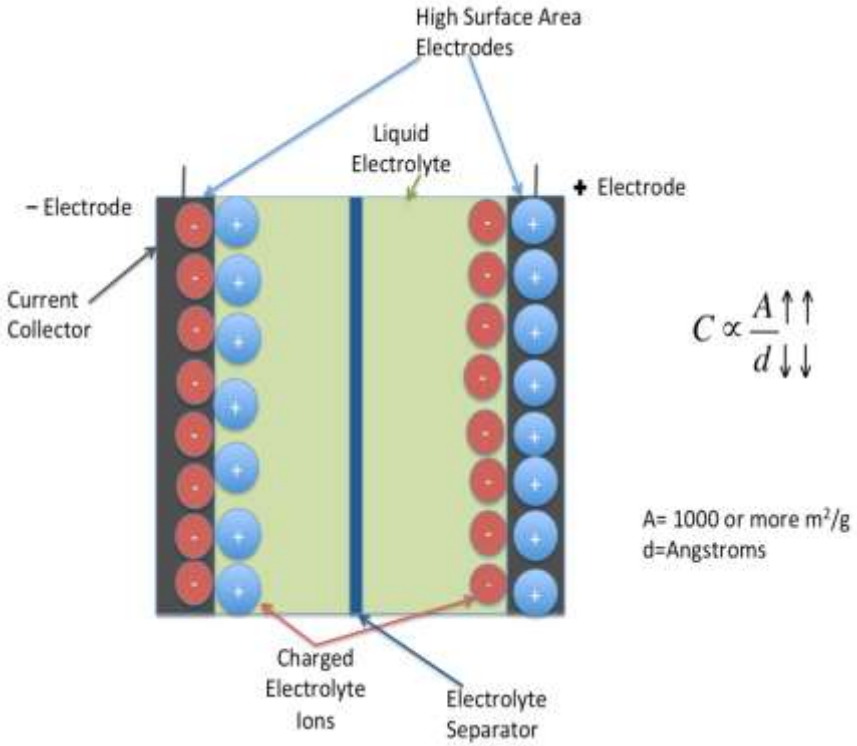
- In present investigation, MnO_2 thin films have been prepared by galvanostatic mode of electrodeposition for the application of supercapacitor.
- The supercapacitive properties of MnO_2 have been studied in 1 M manganese acetate electrolyte.
- Also , CP , CV and impedance graphs are drawn using origin software.

INTRODUCTION

ABOUT SUPERCAPACITOR

Supercapacitors are electrochemical device with following features:

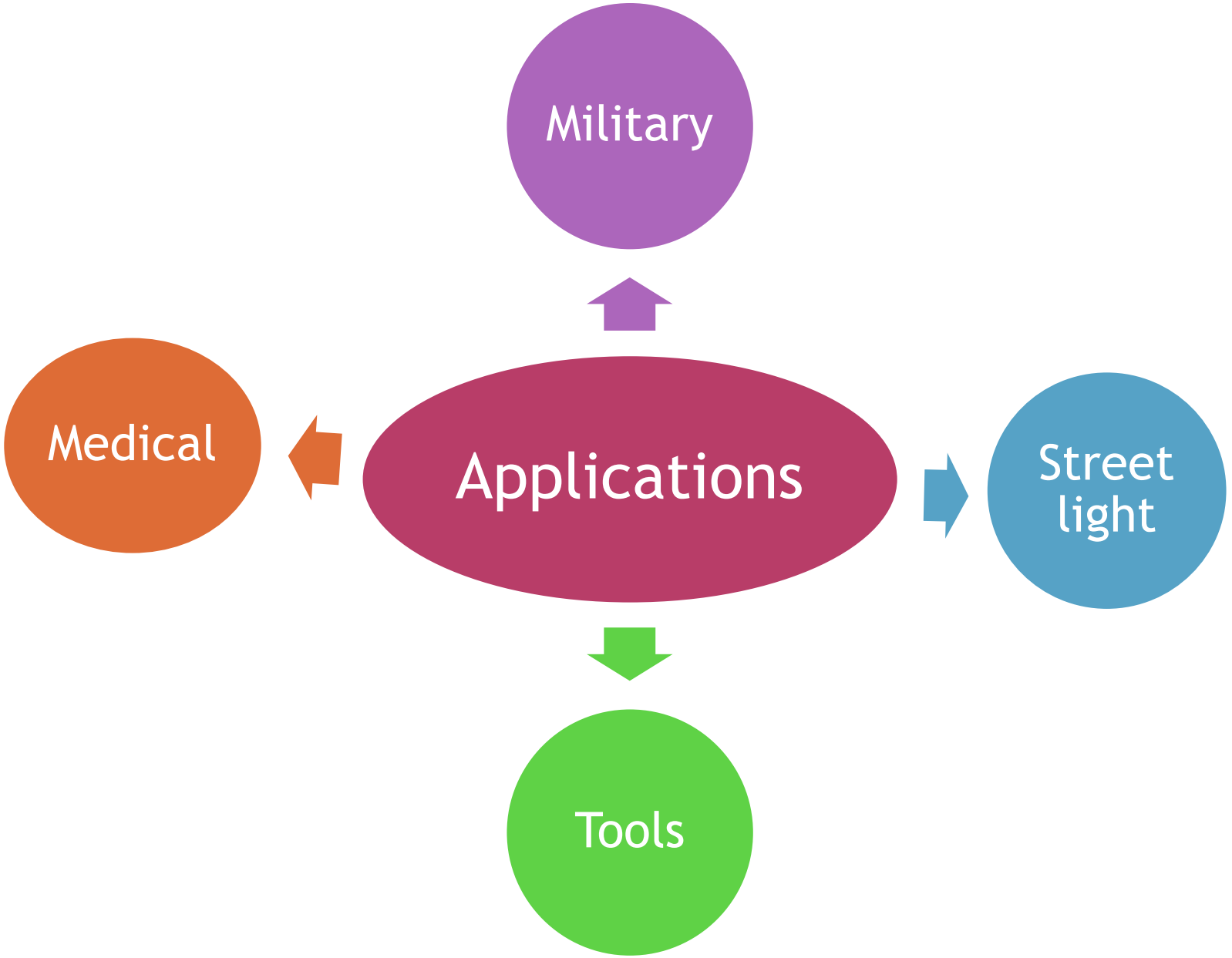
- High energy density.
- High power density.
- High capacitance.
- Longer life.



TYPES OF SUPERCAPACITOR

Supercapacitor

- Electrochemical double layer capacitor
- Pseudo-capacitor
- Hybrid-capacitor

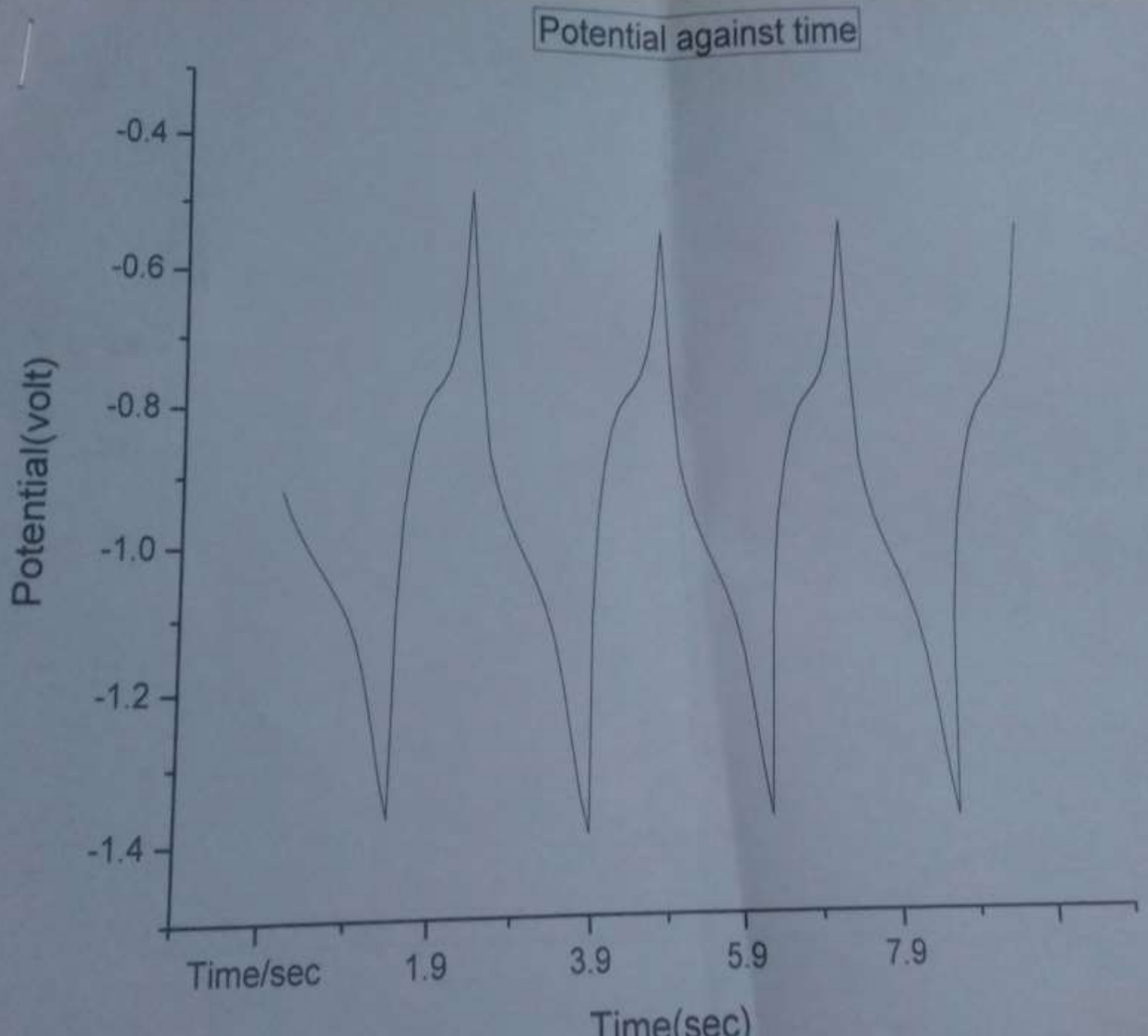

Military
Medical
Applications
Street light
Tools

ADVANTAGES

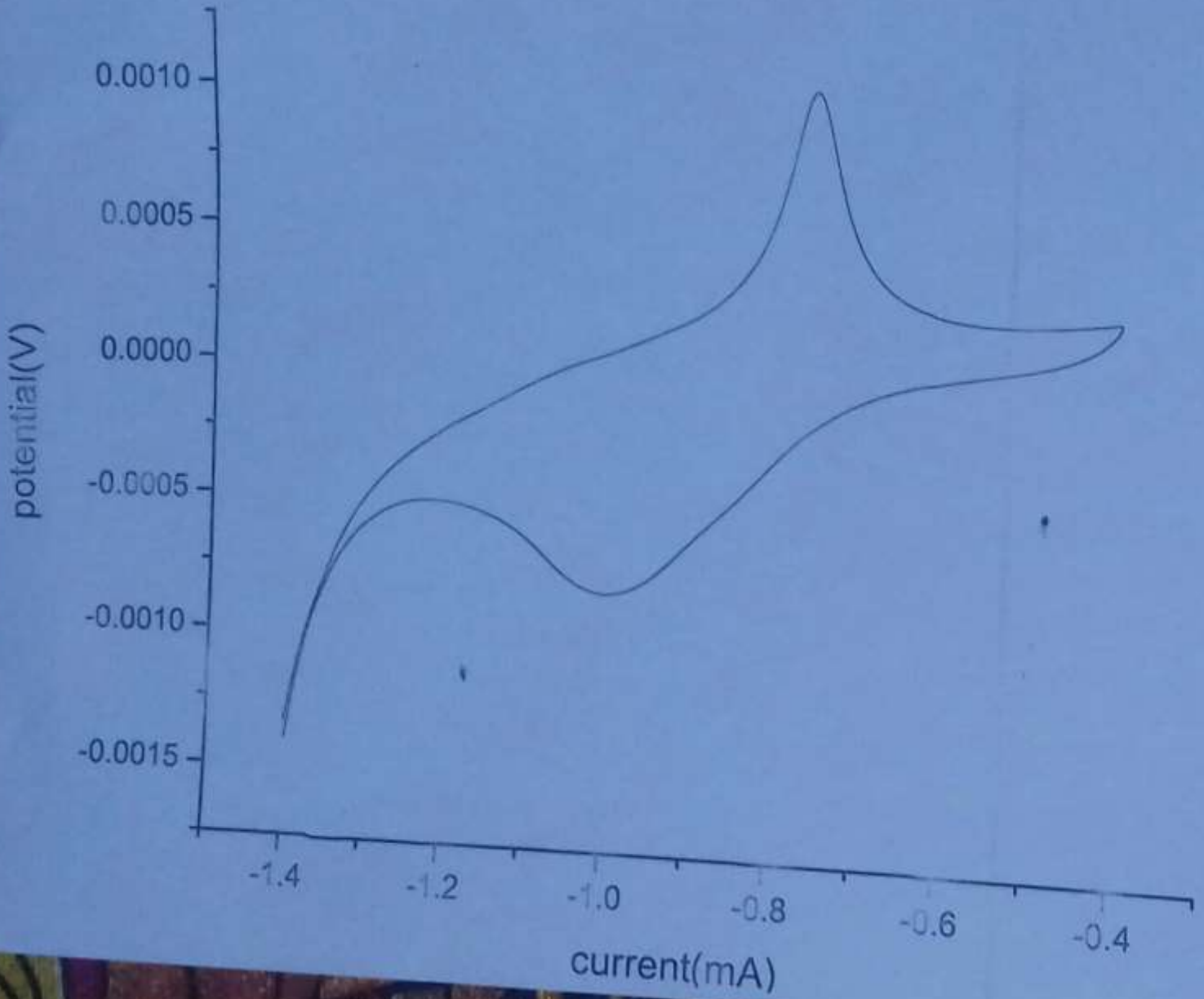
- High specific power .
- Fast charging.
- Low Impedance.

Experimental details

1. Equivalent weight
2. distilled water
3. Take steel substrate
4. Polish the substrate
5. Dip the substrate
6. Give Potential
7. Remove the substrate
8. Thin layer is formed.


Potential against time
Potential(volt)
-0.4
-0.6
-0.8
-1.0
-1.2
-1.4
Time/sec
1.9
3.9
5.9
7.9
Time(sec)

potential vs current → CV [K]

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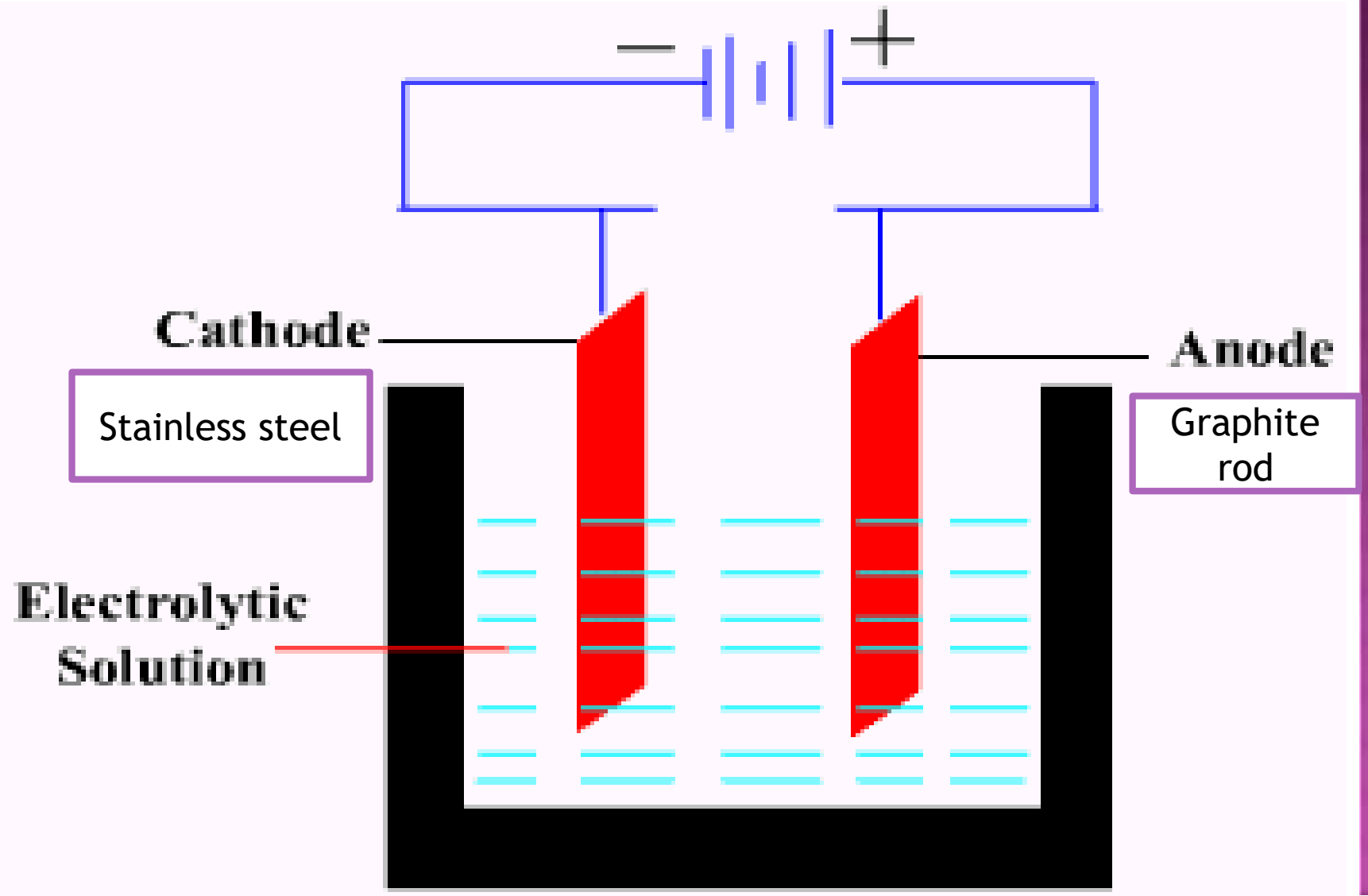
3. Deposition Techniques

There are various methods used for preparation of supercapacitor electrode.

- Chemical methods
- Electrodeposition

SCHEMATIC DIAGRAM OF ELECTRODEPOSITION METHOD



ELECTRODEPOSITION METHOD

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Galvanostatic Electrodeposition :It is essential to have constant current density to have uniform deposition.

DEPOSITED MAGANESE HYDROXIDE

SUPERCAPACITOR CHARACTERIZATION

To measure capacitance,specific capacitance.

We have formula,

Capacitance = Area÷(2×scan rate×P.W.)

Where, P.W. = Potential window

Specific capacitance =Area÷(scan rate×P.W.×

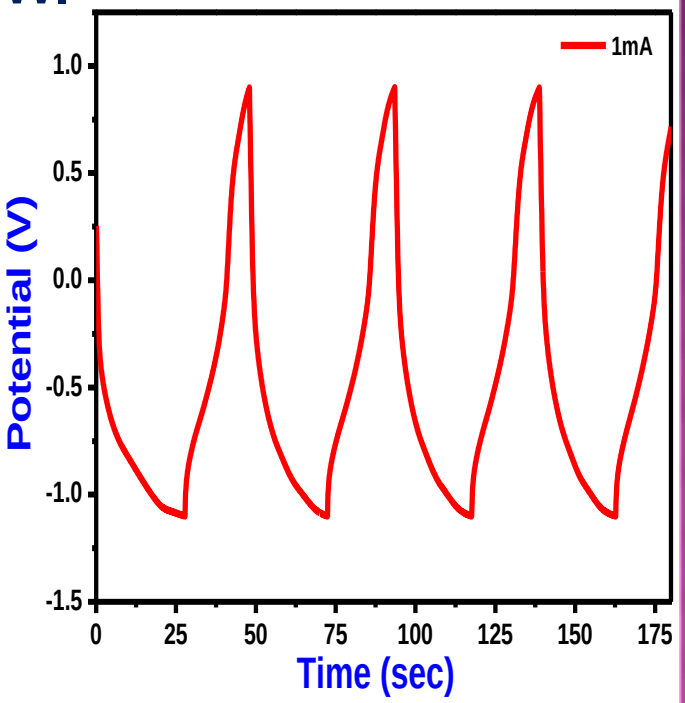
weight loss)

i.e.Specific capacitance=capacitance÷weightloss

SUPERCAPACITOR CHARACTERIZATION

Charge – Discharge Study (CD)

- Specific energy=V*I $_d$*t $_d$ / w.
- Specific power=v*Id/W.
- Efficiency(%)= t $_{d/}$t $_c$ * 100



CONCLUSION

- MnO_2 thin film electrodes are succesfully deposited using potentiostatic electrodeposition method.

- Specific Capacitance - 180.04 F/g
- Specific power – 0.28×10^3 W/kg
- Specific energy –1.2 Wh/kg
- Efficiency - 82%


THANK
YOU

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Exam Seat No._____

Sangola Taluka shetkari shikshan prasarak Mandal Sangola's

Vidnyan Mahavidyalaya, Sangola

Department of Physics

Certificate

This is to certify that Mr./Miss. Gele chhaya Mohan.
Class: B.Sc.III Roll No. 347 has satisfactorily completed ~~SEMINAR/~~ **~~STUDY TOUR~~/ PROJECT REPORT** of Physics prescribed by Solapur University, Solapur during the year 2018-19.

Teacher Incharge

Examiner

Head
Department of Physics

A PROJECT

REPORT on

EFFECT OF POTENTIODYNAMIC MODE OF ELECTRODEPOSITION ON SUPERCAPACITIVE PROPERTIES OF THIN FILM FOR MnO_2

UNDER THE GUIDENCE OF

Dr.THOMBARE J.V

Presented By

Miss. Kharade B.V

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Miss.Lavate S.D

Miss.Raut P.S

IN THE YEAR 2018-19

ABSTRACT

In present investigation MnO_2 thin film have been prepared by potentiodynamic mode of electrodeposition. The effect of mode on supercapacitive properties of MnO_2 thin film have been investigated. All potentiodynamic mode is confirmed from Xray diffraction (XRD) patterns.The supercapacitive properties of MnO_2 thin film have been studied in 1M Manganese acetate electrolyte.Maximum supercapacitance , charge-discharge and impedence of MnO_2 thin film have been investigated.

INTRODUCTION

Supercapacitor have the unique ability to provide higher power and longer cyclic life than batteries for numerous applications such as power sources in next generation electrical vehicles as well as mobile electronic device (1-3) recently carbon metal oxides and conducting polymers are used as supercapacitive materials .supercapacitors based on MnO_2 as active electrode materials are currently attracting a lot of interst due to the relatively low cost , low toxicity , excellent electrochemical performance ,environmentally friendly character in coparison with the other transition metal oxides (4).

Chemical methods are very much sutaible for synthesis of materials than the physical methods since they have good control on the thickness and grainn size (6). Chemical methods have their own advantages such as simplicity , reproducibility, non- hazardous ,cost effectiveness etc. Among different chemical methods electrodeposition is economical and friendly sutaible for large scale applications . The goal of present investigation in the preparation of MnO_2 thin film using potentiodynamic mode.

EXPERIMENTAL DETAILS

Plating bath for MnO_2 thin film was prepared by AR grade chemicals. The bath consisted of an aqueous solution of 0.1M Manganese acetate with solvent as complexing agent. The MnO_2 films are deposited on to the stainless steel foil by potentiodynamic mode (PD) of electrodeposition . Before deposition stainless steel foil was polished with zero grade polish paper and then ultrasonically cleaned with double distilled water.

Pure graphite was used as an anode. All deposition potentials were measured with respect to saturated calomel electrode (SCE) as a reference electrode. The MnO_2 prepared by potentiodynamic mode written by PD: MnO_2.

RESULT AND DISCUSSION

(A) Structural Studies

The XRD pattern of PD: MnO_2 thin film on ss substrate. No distinct diffraction peak other than ss substrate is observed in XRD pattern, which prosbably means that the film consisted of MnO_2 colloidal particles in amorphous phase. The peaks obtained due to ss substrate are indexed by the triangles. The phase of the oxide materials is feasible for supercapacitor application due to easy penetration of ions through the bulk of the active material.

(B) SUPERCAPACITIVE PROPERTIES

There have been two mechanisms proposed for the charge storage in MnO2 based electrodes. The first one is based on the concept of intercalution of H+ or alkali metals cations such as Na+ in the elecrode during reduction and disintercalution upon oxidation [14-16].

$$MnO_2 + H^+ + e^- \longleftrightarrow MnOOH$$

Or

$$MnO_2 + C^- + e^- \longleftrightarrow MnOOC$$

$$(MnO_2)_{surface} + C^+ + e^- \longleftrightarrow (MnO_2^- C^+)_{surface}$$

The second mechanism is based on the surface adsorption of electrolyte cations (C^+) on MnO2. Thus , it has been demostrated that the capacitance of the MnO2 results from its surface redox reaction.

Supercapacitors are electrochemical device with following features

- ⇨ High energy density
- ⇨ High power density
- ⇨ High capacitance
- ⇨ Longer life

C) Impedence Analysis

The impedence spectra of PD:MnO_2 at a fully charged state of 1.2v/SCE. The initial non zero intercept at z' at the beginning of the semicircle is almost identical in all the curves and is due to the electrical resistance electrolyte, of which has the voltage .Therefore , charge transfer resistance values of PD:MnO_2 are given in graph. Thus the PD mode of electrodeposition is high.High energy density and high power density MnO_2 electrode in supercapacitors technology.

CONCLUSION

We have successfully prepared MnO_2 film by potentiodynamic mode .The given data, the values of specific energy, specific power and efficiency for PD:MnO_2 is greater.

REFERENCES

1. B.E.Conway, electrochemical supercapacitor.
2. A .F.Burke
3. L.T .Lam ,power sources
4. S.C .Pang
5. S.Jana, physicist and chemist
6. J.K.Chang
7. Z.P.Feng, electrochemist
8. K.R .Prasad, power sources.