SRI VENKATESWARA INTERNSHIP PROGRAM FOR RESEARCH IN ACADEMICS (SRI-VIPRA)
Student Internship

SRI-VIPRA

Project Report of 2025: SVP-2519

"Silicoaluminophospate (SAPO) templated carbons composites as sensing platform for electrochemical detection of metal ions- computational and experimental approach"

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SRIVIPRA PROJECT 2025

Title : Silicoaluminophosphate (SAPO) templated carbons composites as sensing platform for electrochemical detection of metal ions- computational and experimental approach.

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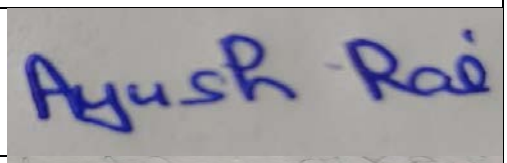
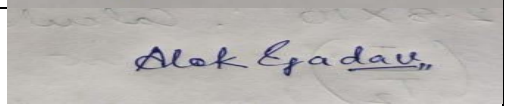
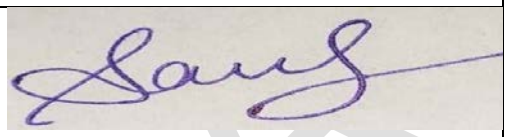
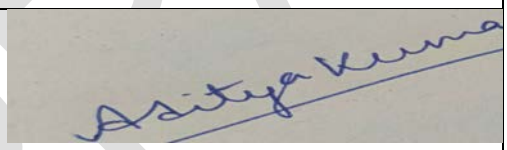
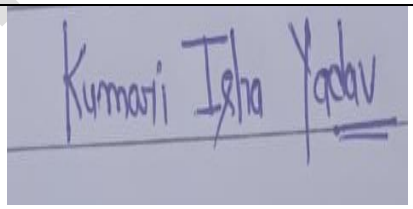
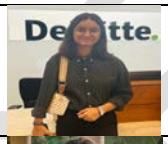
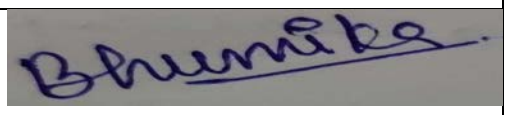
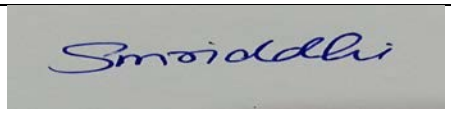
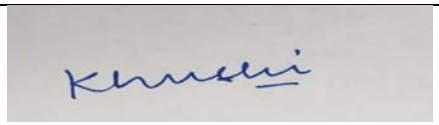
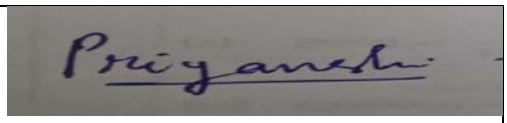
Name of Mentor: Dr. Pragya Gahlot **Name of Department:** Chemistry **Designation:** Assistant Professor	

List of students under the SRIVIPRA Project

S.No	Photo	Name of the student	Roll number	Course	Signature
1		Ayush Rai	1523020	BSC(H) Chemistry	
2		Alok Yadav	1523070	BSC(H) Chemistry	

3		Vishesh Singh	1523084	BSC(H) Chemistry	
4		Saurabh Shukla	1523064	BSC(H) Chemistry	
5		Aditya Kumar	1523036	BSC(H) Chemistry	
6		Kumari Isha Yadav	1523046	BSC(H) Chemistry	
7		Bhumika Singh	1523076	BSC(H) Chemistry	
8		Smriddhi	1122025	Bsc Life Science	
9		Khushi	1122129	Bsc Life Science	

10		Priyanshi Sharma	1524069	BSC(H) Chemistry	

Signature of Mentor

Dr. Rekha Yadav

Dr. Pragya Gahlot

Certificate of Originality

This is to certify that the aforementioned students from Sri Venkateswara College have participated in the summer project SVP-2519 titled "**Silicoaluminophosphate (SAPO) templated carbons composites as sensing platform for electrochemical detection of metal ions- computational and experimental approach”**.The participants have carried out the research project work under my guidance and supervision from 1st July, 2025 to 30th September 2025. The work carried out is original and carried out in an online/offline/hybrid mode.

Signature of Mentor

Dr. Rekha Yadav **Dr. Pragya Gahlot**

Acknowledgements

The students and mentors gratefully acknowledge the Principal, Prof. V. Ravi, Sri Venkateswara College, University of Delhi for the library resources and technical support provided.
A special thanks for SRIVIPRA team for providing the opportunity.

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1. Introduction

Silicoaluminophosphate (SAPO) templated carbons composites as sensing platform for electrochemical detection of metal ions- computational and experimental approach.

2. Objectives

- To prepare Silicoaluminophosphate (SAPO) templated carbons composites using two step procedure
- To study the catalytic activity of prepared material as sensing platform for electrochemical detection of metal ions- computational and experimental approach
- The objective of this project is to develop research aptitude in the student.
- Enhancing research capabilities of the student
- Imparting necessary IT skills for research proposes
- Developing interest in this specific research field to help in choosing the appropriate field in the early phase of their professional career

3. Methodology

(a) Literature Survey

Activated carbons (ACs) are widely used as adsorbents for water and gas purification and as electrode materials in supercapacitors [1]. Recently, increasing attention has been directed toward synthesizing three-dimensionally connected ACs with ordered micropores using zeolites as hard templates, owing to their potential for high conductivity and capacitance. Typically, zeolite-templated carbons are obtained by depositing and pyrolyzing carbon precursors such as furfuryl alcohol, propylene, or acetonitrile within the zeolite framework, followed by template removal using HF or NaOH solutions. However, these etching methods pose safety and environmental challenges, limiting large-scale applicability [2-3]. Silicoaluminophosphates (SAPOs), have emerged as safer alternatives. Unlike aluminosilicate zeolites, $AlPO_4$ can be dissolved in mild acids such as HCl, making them suitable as removable templates. In particular, SAPO-37, with its large pore openings, high acidity, and remarkable thermal stability up to 1000 °C, offers excellent structural properties for carbon precursor infiltration and deposition. Moreover, its low hydrothermal stability enables template removal under mild conditions without HF [4-5].
This study aims to synthesize microporous activated carbon using SAPO-37 as a hard template and propylene gas as the carbon precursor as reported in literature [6], demonstrating an efficient and environmentally friendly route for producing highly conductive, porous carbons suitable for electrochemical sensing applications.

Table 1. Literature Survey

S.No.	Material/Catalyst	Metal	T/°C	Duration	Template	Functionality	Ref

1	SAPO-37 templated carbon	-	900	~3h (CVD & pyrolysis)	SAPO-37	Microporous activated carbon	1
1.1	SAPO-37	Si, Al, P	Upto 1000	-	-	Acts as sacrificial microporous template	1
1.2	Propylene gas (C_3H_6)	-	900	During(CVD) 1-2h	-	Carbon precursor inserted into SAPO-37	1
1.3	Zeolite-Y templated carbon	-	900	~3h	Zeolite-Y	Comparative microporous carbon(control sample)	1
1.4	Zeolite-Y	Si,Al	High thermal stability	-	-	Alternative template used to remove HF	1,2
1.5	HCl + NaOH	-	60	~3h(template removal)	-	Remove SAPO-37 template without HF	1,2
1.6	HCl + HF(for zeolite-Y)	-	-	-	-	Used for dissolving Zeolite-Y template (Hazardous)	1,2
2	SAPO-56 molecular sieve	Si,Al,P	200-220	24-28h (Crystallization)	Seed assisted (SAPO-56 seed)	Adsorbent: CO_2 uptake enhancement / filler in mixed-matrix membranes (MMMs)	2
2.1	Submicron SAPO-56	Si,Al,P	200-220	24-28h (Crystallization)	Seed assist crystallization	Reduced crystal size	2

2.2	Seed crystals (SAPO-56)	Si,Al,P	-	-	Used in synthesis	To control nucleation & reduce final sieve size.	2
3	Hierarchical SAPO-5	Si,Al,P	200 (Hydrothermal)	24-28h Crystallization	Hard carbon/ carbon nanotube	Form mesoporous SAPO-5, accessibility	3
3.1	SAPO-5 with varying mesopore size	Si,Al,P	Same	24-28h Crystallization	Different shape carbon nano-template	Tailors mesopore geometry and hierarchical porosity	3
3.2	Carbon nano template (CNTs)	C	Eliminated later	Hard template in synthesis	Various shapes/size	Direct mesoporosity with SAPO-network	3

(b) Preparation of Catalysts

As per literature the materials can be synthesized in two steps:
(i) Synthesis of SAPO materials- A gel was prepared with a composition of 0.05 tetramethylammonium:2 tetrapropylammonium:Al_2O_3:P_2O_5:0.5 SiO_2:50 H_2O followed by hydrothermal treatment.
(ii) Carbon deposition on SAPO materials followed by dissolution of SAPO framework- Carbon was deposited and pyrolyzed in the SAPO-37 and zeolite Y templates by chemical vapor deposition (CVD) with propylene.

(c) Characterization

The as-synthesized zeolite samples were characterized for structural, morphological, and acidity features by physicochemical techniques such as XRD, SEM, and TPD of ammonia. The Si/Al ratio was determined by atomic absorption spectrophotometry.

(d) Study of catalytic activity of the catalysts

The prepared materials were studied for electrochemical applications.

(e) Use of IT tools

Different IT tools including PPT, word, Origin etc were used.

3. Result and Discussion

The first step of synthesis was successfully achieved by synthesising SAPO-37 materials using the hydrothermal method.
The synthesised materials were characterised using spectroscopic and analytical methods. The prepared materials showed all the characteristics of SAPO-37 materials.

4. Conclusion

The literature survey and first step of synthesis was successfully completed.

5. References

[1]Yunxiang Li, Xia Wang, Thomas Thersleff, Gunnar Svensson, and Niklas Hedin ACS Omega 2019 4 (6), 9889-9895
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[4]Franz Schmidt, Silvia Paasch, Eike Brunner, Stefan Kaskel,Carbon templated SAPO-34 with improved adsorption kinetics and catalytic performance in the MTO-reaction,Microporous and Mesoporous Materials Volume 164,2012, 214-221,ISSN 1387-1811
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[6] Yunxiang Li, Xia Wang, Thomas Thersleff, Gunnar Svensson, and Niklas Hedin ACS Omega 2019 *4* (6), 9889-9895
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6. Future Prospects

- To perform carbon vapour deposition on SAPO-37 for the desired active porous carbon.
- To study the electrochemical applications on the synthesized materials
- To study the material and explore its applications-computational approach.