

DECLARATION BY THE CANDIDATE

DECLARATION

I declare that the thesis entitled “**Studies on the synthesis and characterization of transition metal doped Zeolites and their application to various Eco-friendly synthesis**” is my own work conducted under the supervision of **Prof. (Mrs.) Radha Tomar** at **School of Studies in Chemistry, Jiwaji University, Gwalior (M.P.), India**. I have put in more than 200 days of attendance with the supervisor at the center.

I further declare that to the best of my knowledge this thesis does not contain any part of work which has been submitted for the award of any degree either in this University/Deemed University without proper citation.

Signature of the supervisor

**Dr. Radha Tomar,
Professor,
School of Studies in Chemistry,
Jiwaji University, Gwalior.**

Signature of the Candidate

**Udaypal Singh Thakur,
Research Scholar,
School of Studies in Chemistry,
Jiwaji University, Gwalior.**

**Dr. S. K. Srivastava
Professor & Head
School of Studies in Chemistry
Jiwaji University, Gwalior.**

CERTIFICATE OF THE SUPERVISOR

CERTIFICATE

This is to certify that the work entitled “**Studies on the synthesis and characterization of transition metal doped Zeolites and their application to various Eco-friendly synthesis**” is a piece of research work done by **Udaypal Singh Thakur** under my guidance and supervision for the degree of **Doctor of Philosophy in Chemistry** at **School of Studies in Chemistry, Jiwaji University, Gwalior (M.P.), India**. That the candidate has put in an attendance of more than 200 days with me.

To the best of my knowledge and belief the thesis:

- ❖ Embodies the work of the candidate himself.
- ❖ Has been duly completed.
- ❖ Fulfills requirements of the ordinance relating to Ph.D. degree of the University.
- ❖ Is up to the standard both in respect of contents and language for being referred to the examiner.

Forwarded

Dr. S. K. Srivastava
Professor & Head
School of Studies in Chemistry
Jiwaji University, Gwalior

Signature of the Supervisor

Dr. Radha Tomar
Professor
School of studies in Chemistry
Jiwaji University, Gwalior

Acknowledgements

First and foremost, I wish to pay my sincere homage to Lord Krishna for making me capable of doing all that I propose, the work leading to my Ph. D. thesis submission is one of them.

I would like to gratefully and sincerely thank Dr. Radha Tomar, Professor, School of Studies in Chemistry, Jiwaji University Gwalior (M.P.) for her guidance, understanding and patience during my research work. She encouraged me to not only grow as an experimentalist and a chemist but also as an independent thinker. I owe her gratitude for helping me to complete this work. I greatly benefited from her keen scientific insight, her knack for solving seemingly intractable practical difficulties, and her ability to put complex ideas into simple terms.

I am very much indebted to Dr. S. K. Srivastava for his consistent guidance and motivation during my work.

It is my great pleasure to express my sincere thanks to Prof. K. Dwivedi, Prof. Rajeev Jain, Prof. D.D. Agrawal, Prof. A. K. Halve, and Prof. S.K. Gupta of School of Studies in Chemistry, Jiwaji University Gwalior for their kind guidance, support and encouragement during my research work.

I am deeply indebted to Dr. S.S. Tomar, Professor & Head, Department of Physics, S.L.P. Govt. P. G. College, Gwalior for his kind help and proper guidance.

I feel privileged in paying sincerest thanks to SAIIF (Chandigarh), STIC (Cochin University), CSMCRI and IIT Chennai for providing me necessary instrumental facilities.

I would like to thank my seniors Dr. B. K. Singh, Dr. Deepesh Bhardwaj, Dr. Pankaj Sharma, Dr. S. K. Singh, Dr. Vandana Swarnkar, Dr. Nishi Agrawal, Dr. Jyoti Bhadoria and Dr. Aarti Sharma for their encouragement, timely guidance, advice and providing the homely atmosphere in the laboratory during the tenure of my work. I express my warmest thanks to my fellow colleagues Dr. Sheikh Abdul Majid, Dr. Waheed Ahmad Khanday, Dr. Priya Pawaiya, and Ms. Anidha Agarwal, Mr. Muzzaffar Ahmad Mir and Mr. Rawof Naikoo for their help, fruitful discussions and cooperation. They always provided me a pleasant, working and hilarious environment. I want to thank my friends, Upendra Singh Bais, Mahendra Singh Tomar & Santosh who entertained me.

I would like to thank Dr. Mamta Sharma (Scientist 'D', DRDE Gwalior) for her help in my training during M.Sc. at DRDE and guidance during initial time of my Ph.D. work. I cannot forget her courageous words during that time.

I came in contact of few people who didn't know me. I still do not know why they were helping me without any reason. They are Mr. Shubhankar Bhattacharyya (SRF, IIT Mumbai) and Mr. Asim Bhaumik. I acknowledge them for their support, guidance and suggestions to solve my research problems during all research work. I have been inspired too much due to the helping nature of Mr. Bhattacharyya. I also want to thank central library, Jiwaji University for providing access of several journal articles.

Today I feel that my parent's hard work and dreams have been blossomed. I can imagine today my very first time of

education and tricky teaching by my father Mr. Pratipal Singh who is kind, simple and full of patience. I thank my mother Smt. Maya Devi who inspired me and presented how to face situations and how the hard work is fruitful. It is very elegance moment to acknowledge my elder brother Mr. Bhoopendra Singh and Mr. Garunpal Singh, my sister Miss Anjana Thakur and my Bhavi Smt. Sonam Singh who helped me socially, mentally and moreover economically without that, this work was not possible. I thank to god who gifted me such a great family. I thank my nephews Vicky, Satyamev and Muskan for making me so happy with their cute smile.

Who have given us everything that we possess in this life? The life itself is their gift to us, so I am at loss of words in which to owe my beloved Late Fufaji, Mr. Murlidhar Singh Sengar. It is very heartly and difficult to acknowledge my Late Fufaji and Buaaji (Smt. Rajeshweri Devi Sengar) by these very little words who not only bring me up but also my parents. I am very sure that god is on earth. Fufaji, you left us alone and after you, everything became opposite. I pay my soul homage to you. I wish to have your blessings forever.

I also thank all well wishers and all those persons who helped me directly or indirectly during my Ph.D. and I can't list those names here.

UDAYPAL SINGH THAKUR

Abbreviations and symbols

XRD	-	X-ray Diffraction
FT-IR	-	Fourier Transform Infrared
DRS	-	Diffuse Reflectance Spectroscopy
EDS	-	Energy Dispersive Spectrometry
SEM	-	Scanning Electron Microscopy
BET	-	Brunauer-Emmett-Teller
NMR	-	Nuclear Magnetic Resonance
TMAOH	-	Tetramethylammonium hydroxide
THF	-	Tetrahydrofuran
SDA	-	Structure Directing Agent
g	-	Gram
l	-	Liter
m	-	Meter
T	-	Temperature
K	-	Kelvin
λ	-	Lambda
θ	-	Theta
$^{\circ}$	-	Degree
$^{\circ}\text{C}$	-	Degree centigrade
\AA	-	Angstrom
mg	-	Milligram
M	-	Molar
mL	-	Milli Liter