

Declaration

This is to certify that the thesis titled *Application of clay and silica-alumina supported metal catalyst for hydrogenation and hydrotreatment reaction* submitted by Unnati Gupta to the Indian Institute of Technology Jodhpur for the award of the degree of *Doctor of Philosophy* is a bonafide record of the research work done by her under my supervision. To the best of our knowledge the contents of this report, in full or in parts, have not been submitted to any other institute or university for the award of any degree or diploma.

Prof. Rakesh Kumar Sharma
Ph.D. Thesis Supervisor

Declaration

I hereby declare that the work presented in this Thesis titled "*Application of clay and silica-alumina supported metal catalyst for hydrogenation and hydrotreatment reaction*" submitted to the Indian Institute of Technology Jodhpur in partial fulfillment of the requirements for the award of the degree of Doctor of Philosophy, is a bonafide record of the research work carried out under the supervision of Prof. Rakesh Kumar Sharma. The contents of this thesis in full or in parts, have not been submitted to, and will not be submitted by me to, any other Institute or University in India or abroad for the award of any degree or diploma.

Unnati Gupta

P18CY008

Acknowledgments

First and foremost, I want to express my gratitude and thank God, the almighty, who has granted me countless blessings, health, knowledge, and opportunity, so that I have been finally able to complete the thesis.

I would like to extend my heartiest gratitude towards my PhD supervisor, **Prof. Rakesh Kumar Sharma** for providing his invaluable patience, feedback, and guidance throughout the various stages during the entire period of my research at IIT Jodhpur. I could not have undertaken this journey without his unwavering support, who generously provided knowledge and expertise. I am highly grateful to Dr. Pragati R Sharma for her constant love, support, and encouragement.

I would like to thank my Departmental Committee for their valuable suggestions and encouragement at each stage of my Ph.D.

I am highly indebted to Dr. Krishnapriya for her editing help, late-night feedback sessions, and moral support. Her support has helped me to improve my scientific knowledge and writing skills. I am also thankful to Dr. Bhagirath, Dr. Devika and Dr. Meena for their constant support through out my Ph.D.

I would like to thank SMCRL lab members; Apoorva, Divya, Hemananda, Avleen, Vishav, Preeti, Neha, Kirti, and Abhishek. Thank you for supporting me encouraging and providing a positive environment throughout this experience.

I would like to thank MHRD and IIT Jodhpur for their financial support during my Ph.D. years.

I extend heartfelt gratefulness to the whole CDRSI facility, IIT Jodhpur for providing me with valuable instrumentation facilities for the characterization of samples.

I would also like to thank the Department of Chemistry, IIT Jodhpur, and everyone at IIT Jodhpur – teaching, library, administrative, housekeeping, mess, banking, and canteen staff for providing me with my needs during this tenure.

I would like to thank my family members my parents, my brothers, my sister in law, nephew, and niece for uplifting my mood. Their belief in me has kept my spirits and motivation high during this process.

I would like to thank my husband (Mudit Agarwal) and in-laws who encouraged me to continue Ph.D. after marriage, tolerated my persistent absence from their lives and helped me to balance my marriage and research life.

I would like to dedicate my thesis to my mother Late Deepa Gupta who was the driving force of my joining Ph.D., her prayers and blessings have sustained me thus far, and my father (Vinod Kumar Gupta) who despite all odds and hardships always believed and supported me in all my decisions. I am eternally grateful to them for their love and sacrifices.

Unnati Gupta
Ph.D. Student

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List of Symbols

Symbol	Description
β	Beta
μm	Micrometers
mm	Millimeter
nm	Nanometer
μM	Micromolar
mM	Millimolar
cm	Centimeters
$^{\circ}\text{C}$	Degree celsius
μL	Microliters
mL	Milliliter
%	Percentage
Wt.%	Weight percentage
$\text{\AA}$	Angstrom
θ	Theta
M	Molarity
N	Normality
ppm	Parts Per Million
m	meter
g	gram
eV	electron-volt
mol	mole
mmol	milimole
K	Kelvin
Pa	Pascal
KPa	kilopascal
MPa	Megapascal
h	Hour
MHz	Megahertz

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List of Abbreviations

a.u.	Arbitrary Unit
BDDT	Brunauer-Deming-Deming-Teller
B.E.	Binding energy
BET	Brauner Emmett Teller(method)
BJH	Barrett Joyner Halenda
CTAB	Cetyltrimethylammonium bromide
DCO ₂	Decarboxylation
DCO	Decarbonylation
DI	De-ionized
DO	Deoxygenation
DMF	Dimethylfuran
EDX, EDS	Energy-dispersive X-ray spectroscopy
EPR	Electron paramagnetic resonance
FAME	Fatty acid methyl esters
FID	Flame ionization detection
FTIR	Fourier-transform infrared
GC	Gas chromatography
HDO	Hydrodeoxygenation
HDS	hydrodesulfurization
HMF	Hydroxymethylfurfural
HR-MS	High-Resolution Mass Spectroscopy
HR-TEM	High Resolution Transmission Electron Microscope
ICP-OES	Inductively Coupled Plasma Optical Emission
JCPDS	Joint Committee on Powder Diffraction Standards
MO	Methyl oleate
MMT	Montmorillonite
NMR	Nuclear magnetic resonance spectroscopy
NP	Nanoparticle
PGM	Platinum group metals
rpm	Revolution per minute
RT	Room temperature
SA	Silica-Alumina
SEM	Scanning Electron Microscope
SAED	Selected Area Electron Diffraction
TCD	Thermal conductivity detector
TEM	Transmission electron microscopy
TGA	Thermal Gravimetric Analysis
TON	Turn over number
TPD	Temperature Programmed Desorption
TPR	Temperature Programmed Reduction
UV-vis	Ultraviolet-Visible Spectroscopy
XPS	X-ray Photoelectron Spectroscopy
XRD	X-ray Diffraction
XRF	X-ray fluorescence
ZSM	Zeolite Socony Mobil

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