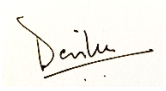
Declaration

I hereby declare that the work presented in this Thesis titled *Advanced Functional Nanomaterials for Energy and Environmental Applications* submitted to the Indian Institute of Technology Jodhpur in partial fulfilment 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 Dr. 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.



Devika Laishram
P15CY001

Certificate

This is to certify that the thesis titled *Advanced Functional Nanomaterials for Energy and Environmental Applications*, submitted by *Devika Laishram* (P15CY001) 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 our 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.

Rakesh Kumar Sharma
Ph.D. Thesis Supervisor

Ritu Gupta
Ph.D. Thesis Co-Supervisor

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Devika Laishram
PhD Student

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List of Symbols

Symbol	*Description*
α	Alpha
β	Beta
π	Pie
$C{=}O$	Carbonyl group
λ_{max}	Maximum wavelength
λ_{em}	Emission wavelength
λ_{ex}	Excitation wavelength
C_{SC}	Chemical capacitance
Ω	ohm
C_T	Electrolyte capacitance
T_{10}	Onset temperature
T_{50}	Light off temperature
T_{90}	Maximal conversion temperature
T_m	Peak temperature
$-NH_2$	Amino group
T_m	Melting temperature
T_{10}	The temperature at which 10% of the total weight loss occurs
$T5_0$	Light off temperature at which 50% of the total weight loss occurs
$T9_0$	The temperature at which 90% of the total weight loss occurs
µM	Micrometers
mM	Millimeter
nm	Nanometer
-OH	Hydroxyl group
$-O-CH_3$	Methoxy group
cm	Centimeters
°C	Degree celsius
J_O	Exchange current density
J_{lim}	Limiting current density
E_{pp}	Peak to peak potential
O_β	Lattice oxygen
O_α	Chemisorbed oxygen
N_3	Ruthenium based dye
τ	Lifetime
HCl	Hydrogen chloride
n	Binding parameter
µL	Microliters
Hz	Hertz
V	Voltage
$CaCl_2$	Calcium chloride
KOH	Potassium hydroxide
R_S	Series resistance
R_{ct}	Charge transport resistance
V_{OC}	Open circuit Potential
J_{sc}	Short circuit potential
F	farad
R1, R2	Counter electrode and electrolyte charge transfer resistance

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List of Abbreviations

AIP	*All-inorganic perovskite*
ALD	*Atomic Layer Deposition*
AM	*Air Mass*
a.u.	*Arbitrary Unit*
B.E.	*Binding Energy*
BET	*Brauner Emmett Teller*
BJH	*Barrett Joyner Halenda*
CE	*Counter Electrode*
CN	*Carbon nitride*
CNB	*Carbon nanobubble*
CNT	*Carbon Nanotube*
CPE	*Constant Phase Element*
CR	*Cresol Red*
CS	*Carbon sphere*
CV	*Cyclic Voltammetry*
DI	*De-ionized*
DRS	*Diffuse Reflectance Spectra*
DSSC	*Dye-Sensitized Solar Cells*
EIS	*Electrochemical Impedance Spectroscopy*
FCC	*Face Centered Cubic*
FE-SEM	*Field Emission Scanning Electron Microscope*
FF	*Fill Factor*
FWHM	*Full Width Half Maximum*
FTO	*Fluorine Doped Tin Oxide*
g-C_3N_4	*Graphitic carbon nitride*
GCN	*Graphitic Carbon nitride*
GW	*Gigawatt*
HIP	*Hafnium isopropoxide*
HDA	*Hexadecylamine*
HOMO	*Highest Occupied Molecular Orbital*
HR-TEM	*High Resolution Transmission Electron Microscope*
ICDD	*International Centre for Diffraction Data*
JCPDS	*Joint Committee on Powder Diffraction Standards*
LHE	*Light Harvesting Efficiency*
LUMO	*Lowest Unoccupied Molecular Orbital*
MB	*Methylene blue*
MO	*Methyl orange*
MWCNT	*Multi-walled Carbon Nanotube*
NBE	*Near Band Edge*
NCs	*Nanocrystals*
NIR	*Near-Infrared*
OA	*Oleic Acid*
OAm	*Oleylamine*
ODE	*1-octadecene*
PCE	*Photo Conversion Efficiency*
PL	*Photoluminescence Spectroscopy*
PV	*Photovoltaic*
rpm	*Revolution per minute*
SAED	*Selected Area Electron Diffraction*
SB	*Solochrome black*
SNP	*Nanospheroids*
TTIP	*Titanium tetra isopropoxide*
TB	*Thymol blue*
TPD	*Temperature Programmed Desorption*
TPO/R	*Temperature Programmed Oxidation/Reduction*
TW	*Terra watt*

UV-vis	*Ultraviolet-Visible Spectroscopy*
XRD	*X-ray Diffraction*
XPS	*X-ray Photoelectron Spectroscopy*

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