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It is further certified that the student has fulfilled all the requirements of Comprehensive Examination, Candidacy, and SOTA for the award of Ph. D Degree.

Date: 26/11/2024
Place: Varanasi

D. Tiwari
Prof. Dhanesh Tiwari
(Supervisor)
Department of Chemistry
Indian Institute of Technology
(Banaras Hindu University),
Varanasi-221005

Dr. Dhanesh Tiwari
Professor
राज्य विज्ञान विभाग
Department of Chemistry
भारतीय प्रौद्योगिकी संस्थान (का.हि.वि.वि.)
Indian Institute of Technology (BHU)
Varanasi-221005/Varanasi-221005

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I, **Amisha Soni**, certify that the work embodied in this thesis is my own bonafide work and carried out by me under the supervision of **Prof. Dhanesh Tiwary** from **July-2018** to **November-2024**, at the **Department of Chemistry, Indian Institute of Technology, (BHU), Varanasi**. The matter embodied in this thesis has not been submitted for the award of any other degree/diploma. I declare that I have faithfully acknowledged and given credits to the research workers wherever their works have been cited in my work in this thesis. I further declare that I have not willfully copied any other's work, paragraphs, text, data, results, etc., reported in journals, books, magazines, reports, dissertations, theses, etc., or available at websites and have not included them in this thesis and have not cited as my own work.

Date: 26/11/2024

Place: Varanasi



(Amisha Soni)

CERTIFICATE BY THE SUPERVISOR

It is certified that the above statement made by the student is correct to the best of my/our knowledge.

D. Tiwary
Supervisor

Prof. Dhanesh Tiwary
Professor

Department of Chemistry

Indian Institute of Technology

(Banaras Hindu University)

Varanasi- 221005

Co-supervisor

Manisha Malviya

Dr. Manisha Malviya

Department of Chemistry

Indian Institute of Technology

(Banaras Hindu University)

Varanasi- 221005

S. Singh
Head of Department

रसायन विज्ञान विभाग

Department of Chemistry

Indian Institute of Technology (B.H.U.)

Varanasi- 221005

Indian Institute of Technology

(Banaras Hindu University),

Varanasi- 221005

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Name of the Student: **Amisha Soni**

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(Amisha Soni)

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List of Symbols/Abbreviations

C_{dl}	Double-layer capacitance
cm	Centimeter
CP	Chronopotentiometry
ECSA	Electrochemically active surface area
CV	Cyclic voltammetry
EDS	Energy dispersive spectroscopy
EIS	Electrochemical impedance spectroscopy
FTO	Fluorine doped tin oxide
HER	Hydrogen evolution reaction
HR-TEM	High-resolution transmission electron microscopy
iR	Internal resistance
FT-IR	Fourier transform infrared spectroscopy
kJ	Kilo joule
LSV	Linear sweep voltammetry
mA	Milli ampere
mV	Milli volt
OER	Oxygen evolution reaction
Oh	Octahedral
P-XRD	Powder X-ray diffraction
R_s	Solution resistance
R_{ct}	Charge transfer resistance
RHE	Reversible hydrogen electrode
RT	Room temperature
SAED	Selected area electron diffraction pattern
FE-SEM	Field emission-scanning electron microscopy
UV-Vis	Ultraviolet-visible
R_f	Roughness factor
μF	Micro farad
dec	Decade
Mj	Mega joule

kg	Kilo gram
$\Delta H_{el}^{0\ddagger}$	Standard electrochemical energy of activation
$\Delta S_{el}^{0\ddagger}$	Standard entropy of activation
$\Delta H^{0\ddagger}$	Standard enthalpy of activation
α	Transfer coefficient
GCE	Glassy carbon electrode
SEC	Spectro-electrochemistry
k_B	Boltzmann constant
h	Planck constant
C_{OH^-}	Hydroxyl ion concentration
R	Universal gas constant
b	Tafel slope
T	Temperature
F	Faraday constant
j	Joule
η_{10}	Overpotential at 10 mA cm ⁻² current density
NHE	Normal hydrogen electrode
η_1	Overpotential at 1 mA cm ⁻² current density