“Creativity is seeing the same thing but thinking differently”

~ Avul Pakir Jainulabdeen Abdul Kalam

Declaration

I hereby declare that the thesis entitled "***Layer Dependent Physical and Chemical properties in Two Dimensional Carbon based materials and their heterostructure***" submitted to The School of Sciences, Tezpur University, in partial fulfilment of the requirements for the award of the degree of Doctor of Philosophy in Physics, has been carried out by me at Department of Physics, Tezpur University, Assam, India, under the supervision of Professor Pritam Deb. The work is original and has not been submitted in part or full in any other university or institute for any degree, diploma, associateship, fellowship or any other similar title or recognition.

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CERTIFICATE OF THE PRINCIPAL SUPERVISOR

This is to certify that the thesis entitled "***Layer Dependent Physical and Chemical properties in Two Dimensional Carbon based materials and their heterostructure***" submitted to the School of Sciences, Tezpur University in partial fulfilment for the award of the degree of Doctor of Philosophy in Physics, is a record of research work carried out by **Ms. Meenakshi Talukdar** under my supervision and guidance.

All help received by her from various sources have been duly acknowledged. No part of this thesis has been submitted elsewhere for award of any other degree.

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CERTIFICATE OF THE EXTERNAL EXAMINER AND ODEC

This is to certify that the thesis entitled ***"Layer Dependent Physical and Chemical properties in Two Dimensional Carbon based materials and their heterostructure***" by **Ms. Meenakshi Talukdar** to Tezpur University in the Department of Physics under the School of Sciences in partial fulfilment for the award of the degree of Doctor of Philosophy in Physics, has been examined by us and found to be satisfactory.

The committee recommends for the award of the degree of Doctor of Philosophy.

Signatures:

Supervisor **External examiner**

Date: **Date:**

Dedicated to My Beloved Parents

Mr. Hiralal Talukdar

and

Mrs. Hemalata Talukdar

Acknowledgment

Foremost, I am deeply indebted to my supervisor ***Prof. Pritam Deb of Department of Physics, Tezpur University,*** *for his continuous support, motivation, and patience throughout this voyage. This endeavour would not have been possible without his constant guidance and instructions. His supervision and fruitful discussions have helped me in maintaining a steady pace of work and also have helped me in building up my self-confidence to a great extent. I will always cherish the memories of my association with him.*

I express my sincere thanks to my doctoral committee members ***Prof. Gazi Ameen Ahmed and Dr. Shyamal Kumar Das of Department of Physics, Tezpur University****, for their valuable suggestions and support during my research work.*

I gratefully acknowledge our collaborators ***Dr. Nirmal Mazumder*** *and* ***Dr. Sanjiban Chakrabarty of Manipal School of Life Sciences,*** *for providing me with Biological facilities. I express my appreciation towards the* ***Sophisticated Analytical Instrument Facility (SAIF) of North-Eastern Hill University, Shillong, Institute of Advanced Study in Science and Technology (IASST) Guwahati,*** *and* ***North East Institute of Science and Technology, Jorhat*** *for providing the TEM, AFM and FESEM characterization facilities respectively. I would also like to extend my gratitude to* ***Dr. Pabitra Nath and Prof. Dambarudhar Mohanta of the department of Physics, Tezpur University*** *for their support in conducting the Raman scans and UV analysis.*

I would like to acknowledge the funding sources for supporting me in carrying out my research work, without any financial trouble. Initially, I was an Institutional fellow student, funded by ***Tezpur University.*** *Later on, I got selected as a Senior Research Fellow under the* ***Human Resource Development (HRD) Group of the Council of Scientific and Industrial Research (CSIR), India****.*

I would like to acknowledge the ***technical staff of the Department of Physics*** *and* ***Sophisticated Analytical Instrumentation Centre (SAIC) of Tezpur University*** *for their support in carrying out the experiments with numerous analytical instrument*

facilities. I offer my gratitude to the entire fraternity of Tezpur University for giving me all types of amenities for the fruitful execution of my research work.

I express my heartfelt gratitude to Deepak Bhaiya, Kakoli Ba, Koushik Da, Kashmiri Ba, and Sushant Bhaiya who were my senior lab mates at Advanced Functional Material Laboratory, Department of Physics, Tezpur University for their interest, suggestions, and valuable help.

Thanks should also go to my friends and juniors Kashmiri, Saransha, Monica, Sayoree, Liyenda, and Anil for their timely help, support, and their wholehearted cooperation.

I consider myself to be very lucky as I have met Mayuri and Korobi, who are my lab mates. During my Ph.D. tenure, they supported me. They always inspired me to do something new. Thank you for being my rock and supporting me in this journey. I would not have made it without you two. Your support keeps me going.

It would be remiss in not mentioning the name of Aftab Da. Thanks for being there whenever I was in need during my Ph.D. and for the valuable support throughout my research work.

It's my pleasure to express my deepest gratitude towards my loved and respected ***parents (Deuta and Ma)*** *for their infinite support through these hard times and for affection during the happiest time. I am immensely grateful to my elder sister (**Juri**), brother-in-law (**KKB**), and my brother (**Babu**) for their encouragement and motivation. I would also like to thank my husband **Deep** for his priceless and valuable support during this beautiful journey. Their encouragement leads me to the successful completion of this thesis. Also, I express my heartful gratitude and affection to my parents-in-law Mr. Premeswar Nath and Mrs. Rupali Devi, and sisters-in-law Parishmita Devi for extending moral support during the tenure of my doctoral research.*

Finally, I owe all my endeavours to ***Almighty God*** *for granting me the mental health and strength to accomplish this research work.*

Place: **(Meenakshi Talukdar)**

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650nm; and (i) Ex: 405nm and Em: 420-600nm.

List of Abbreviations

Abbreviation	Full form
0-D	Zero Dimensional
1-D	One Dimensional
2-D	Two Dimensional
3-D	Three Dimensional
AAS	Atomic absorption spectrometry
AFM	Atomic Force Microscopy
BET	Brunauer–Emmett–Teller
BJH	Barrett-Joyner-Halenda
BFGS	Broyden-Fletcher-Goldfarb-Shanno
CN	Carbon Nitride
CA	Contrast Agent
CDC	Center for Disease Control and Prevention
CAGR	Compound Annual Growth Rate
CV	Cyclic Voltammetry
C_Q	Quantum Capacitance
DFPT	Density functional perturbation theory
DFT	Density functional theory
DOS	Density of states
DLS	Dynamic light scattering
EIS	Electrochemical Impedance Spectroscopy
EDX or EDS	Energy Dispersive X-rays Spectroscopy

EDLC	Electric double layer capacitor
FC	Field cooled
FT-IR	Fourier transform infrared
GCD	Galvanostatic Charge-Discharge
GGA	Generalized Gradient Approximation
GC-MS	Gas chromatography–mass spectrometry
HRTEM	High Resolution Transmission Electron Microscopy
IUPAC	International union of pure and applied chemistry
JCPDS	Joint Committee on Powder Diffraction Standards
LDOSs	Local Densities of States
MB	Methylene blue
MTT	3-(4,5-dimethythiazol-2-yl)-2,5-diphenyl tetrazolium bromide
MNP	Magnetic Nanoparticles
MRI	Magnetic Resonance Imaging
MPG	Max Plank Group
NMP	N-Methyl-2-pyrrolidone
NIR	Near Infrared
PVdF	Polyvinylidene fluoride
PDT	Photodynamic Therapy
PEG	Polyethylene glycol
PVP	Polyvinylpyrrolidone
PTT	Photothermal Therapy

PPMS	Physical property measurements system
PL	Photoluminescence
PBE	Perdew-Burke-Ernzerhof
QE	QUANTUM Espresso
RhB	Rhodamine B
ROS	Reactive Oxygen Species
SA	Stearic acid
SEM	Scanning electron microscope
SSC	Sandwich-supercapacitor
SAED	Selected area electron diffraction
TEM	Transmission electron microscope
TG-MSC	T-Graphene based micro-supercapacitor
TGA	Thermogravimetric analysis
UV	UV-Vis spectrophotometer
vdW	van der Waals
VSM	Vibrating sample magnetometer
WVTR	Water Vapour Transmittance Rate
XRD	X-ray diffraction
ZFC	Zero field cooled

List of Symbols

Symbol	Meaning
h	Planck constant
Q_e	Adsorption capacity
k	Boltzmann constant
H_c	Coercivity
M_s	Saturation magnetization
D	Diffusion co-efficient
T_B	Blocking temperature
Tc	Curie temperature
M_R	Remanence
ζ	Zeta potential
μ, Λ, η, β, γ, δ, ρ	Parameter in DFT formalism
N	Avogadro's number