Declaration

I hereby declare that the work presented in this thesis titled *High performance optical and gas sensors based on 2D/3D heterostructures* 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 Mahesh Kumar. The contents of this thesis are 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 award of any degree or diploma.

Neeraj Goel
P15VSS202

Certificate

This is to certify that the thesis titled *High performance optical and gas sensors based on 2D/3D heterostructures*, submitted by *Neeraj Goel* (P15VSS202) 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 him under my supervision. To the best my knowledge, the contents of this thesis, in full or in parts, have not been submitted to any other Institute or University for the award of any degree or diploma.

Dr. Mahesh Kumar
Ph.D thesis Supervisor
13/11/2020

Acknowledgements

I would like to thank my PhD Thesis Supervisor, *Professor Mahesh Kumar*, for giving me an opportunity to work on this new exciting research area. I am grateful to him for introducing me to the field of low dimensional materials. His *technical and nontechnical advice, support, patience and supervision* motivates me throughout this research work. Also, I am very thankful to the members of my Doctoral Committee, *Professor Shree Prakash Tiwari, Professor Satyajit Sahu* and *Professor Manikandan Paranjothy*, for their guidance and support during this research work.

I would also like to thank *Professor S. B. Krupanidhi* (IISc- Bangalore), *Professor Govind Gupta* (NPL, New Delhi), *Professor Mukesh Kumar* (IIT Ropar, India), and *Professor Mirabbos Hojamberdiev* (Technische Universität Berlin) for sharing their labs facilities and providing technical assistance for my research work.

I am grateful to Ministry of Electronics & Information Technology, Government of India, for providing the fianancal support under the Visvesvaraya PhD Scheme during my Ph.D. tenure.

A special thank to all my laboratory mates *Rahul, Amit, Adarsh, Vijendra, and Saravanan Rajamani* for their support and creating a joyful place to work, and all my friends who made an enjoyable and memorable journey at IIT Jodhpur.

I acknowledge and thank my family. Their patience, support and love helped me a lot to complete this research work.

Neeraj Goel
Ph.D. Student

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Symbol	*Description*
θ	Angle of incident
A or S	Area
E_g	Bandgap energy
Φ_B	Barrier height
k	Boltzmann constant
V_{bi}	Build-in potential
ΔI	Change in current
ΔR	Change in resistance
ΔV	Change in voltage
ΔE_c	Conduction band offset
I_a or I_o	Current in air
I_g	Current in the target gas
E_c	Conduction band energy
τ_d	Decay time
I_d	Dark Current
D*	Detectivity of photodetector
W	Depletion width
q	Electron charge
G	Electron conduction
χ	Electron effinity
μ	Electron mobility
$q\,\varphi_r$	Energy difference in conduction band and Fermi level
υ	Frequency
η	Ideality factor
P_i	Input power
c	Lattice constant
l	Length
Φ_m	Metal work function
T	Operating temperature
h	Plank constant
I_p	Photocurrent
n	Power coefficient
S	Relative response
R_a	Resistance in air
R_g	Resistance in the target gas
R	Responsivity of photodetector
A*	Richardson constant
τ_r	Rise time
Ev	Valance band energy
ΔE_v	Valance band offset
V_a	Voltage in air
V_g	Voltage in the target gas
λ	Wavelength
W	Watt

Abbreviation	*Full form*
AFM	Atomic force microscopy
BE	Binding energy
CVD	Chemical vapor deposition
I-V	Current-voltage
D	Dimentional
DFT	Density functional theory
FESEM	Field emission scanning electron microscopy
FET	Field-effect transistor
IoT	Internet of Things
LED	Light-emitting diode
MFC	Mass flow controller
Mo	Molybdenum
MoS_2	Molybdenum disulfide
1D	One-dimensional
PL	Photoluminescence
PVD	Physical vapour deposition
ppm	Parts per million
ppb	Parts per billion
RF	Radiofrequency
RMS	Root mean square
RT	Room temperature
SEM	Scanning electron microscopy
S	Sulfur
SCCM	Standard cubic centimetres per minute
TE	Thermionic emission
2D	Two-dimensional
3D	Three-dimensional
TMDCs	Transition metal di-chalcogenides
UPS	Ultraviolet photoelectron spectroscopy
Uv-Vis	Ultraviolet- visible
vdW	Van der Waal
XPS	X-ray photoelectron spectroscopy
XRD	X-ray diffraction
0D	Zero-dimensional