Declaration

I hereby declare that the work presented in this Thesis titled *Metal Oxide Semiconductor based Gas Sensors* 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 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.



Vijendra Singh Bhati
P14PH004

Certificate

This is to certify that the Thesis titled *Metal Oxide Semiconductor based Gas Sensors*, submitted by *Vijendra Singh Bhati* (P14PH004) 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 of my 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.

Dr. Mahesh Kumar
Ph.D. Thesis Supervisor

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Vijendra Singh Bhati
Ph.D. Student

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List of Symbols

Symbol	*Description*
S	Relative response
R_a	Resistance in air
R_g	Resistance in gas
ΔR	Change in resistance
ΔV	Change in voltage
ΔI	Change in current
V_a	Voltage in air
I_a	Current in air
λ	Wavelength
θ	Bragg angle
K	Scherrer constant
β	Full width half maximum
ε	Microstrain
c	Lattice constant
μ	Micro
KV	Kilovolt
Si	Silicon
Hz	Hertz
h	Plank constant
υ	Frequency
E_g	Band gap
A	Area
ϕ_b	Barrier height
k	Boltzmann constant
J	Current density
q	Charge
E_C	Conduction band energy
E_F	Fermi energy
E_V	Valance band energy
Ω	Ohm
τ_d	Decay time
τ_r	Rise time
χ	Electron affinity
η	Ideality factor
E_k	Kinetic energy
n	Nano
d	Inter plane distance
Φ_m	Metal work function
T	Operating temperature
V_r	Reverse bias voltage
A*	Richardson constant
β	Interface related parameter
$\Delta\phi_b$	Effective barrier height
R_{res}	Response time
R_{rec}	Recovery time

List of Abbreviations

Abbreviation	*Full form*
IUPAC	International Union of Pure and Applied Chemistry
ISFET	Ion selective field effect transistor
IDT	Interdigitated transducer
SAW	Surface acoustic wave
IR	Infrared
NDIR	Non-dispersive infrared
SPR	Surface plasmon resonance
MOS	Metal/oxide/semiconductor
MOM	Metal/oxide/metal
MOx	Metal Oxide
LOD	Limit of detection
FET	Field effect transistor
D	Dimensional
I-V	Current-Voltage measurement
ZnO	Zinc oxide
TiO2	Titanium dioxide
V2O5	Vanadium pentoxide
rGO	Reduced graphene oxide
CNF	Carbon nanofiber
FSP	Flame spray pyrolysis
NWs	Nanowires
RH	Relative humidity
NRs	Nanorods
CNT	Carbon nanotube
FESEM	Field emission scanning electron microscopy
XRD	X-ray diffraction
UV	Ultraviolet
AFM	Atomic force microscopy
XPS	X-ray photoelectron spectroscopy
EDX	Energy dispersive X-ray spectroscopy
LSPR	Localized surface plasmon resonance
PPM	Part per million
PVD	Physical vapor deposition
RF	Radio frequency
CVD	Chemical vapor deposition
MFC	Mass flow controller
IDE	Interdigitated electrode
CRT	Cathode ray tube
FWHM	Full width half maximum
VBM	Valance band maxima
FTIR	Fourier transformed infrared spectroscopy
KPFM	Kelvin probe force microscopy
CPD	Contact potential difference
AC	Alternative current
DC	Direct current
CL	Cathodoluminesence
NBE	Near band emission

V_o	Oxygen vacancies
J	Joule
GO	Graphene oxide
RMS	Root mean square
PAN	Polyacrylonitrile
PMMA	Poly(methylmethacrylate)
DMF	Dimethylformamide
DI	Deionized