CHAPTER 54

TECHNOLOGY
APPLIED SCIENCES AND HUMANITIES

Doctoral Theses

01. JAIN (Tapasya)
Studies on Preparation and characterization of HgCdTe Based Heterostructures for IR Detector Applications.
Supervisors: Prof. O.P. Thakur and Dr. R.K. Sharma
Th 23196

Abstract
(Not Verified)

HgCdTe, a ternary semiconductor alloy of HgTe and CdTe, is material of high technological importance for fabrication of IR detector elements because of its fundamental properties such as tunable bandgap, high absorption coefficient, low thermal and dielectric constant. This thesis explores some of the techniques for preparing p/n HgCdTe photodiode heterostructures using heat treatment with GaAs wafer source and Arsenic Ion Implantation on Indium doped base layer. A remarkable contribution of this thesis has been the utilization of non-destructive technique of Variable magnetic field Hall measurement as a versatile tool for the estimation of Electrical properties of p/n diode structure. The heterostructures so prepared were characterized using Secondary Ion mass spectrometry and Multicarrier Fitting analysis. During the course of these studies, some interesting physical phenomenon such as Shubnikov-de-Haas resistivity oscillations and Hopping conduction were observed. Investigation of these effects led us to conclude the existence of a 2DEG at CdZnTe/HgCdTe interface of both p- and n-type epitaxial layers. Their presence attributed to segregated impurities and misfit dislocation network at the growth interface. Also an effort has been made to optimize the annealing conditions that can be suitably utilized to achieve an optimized CdTe/HgCdTe interface for passivation. It is expected that results presented in this thesis will help in advancing the research for development of simple p/n heterostructures for the purpose of fabrication of large size IR detector focal plane arrays.

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02. MISHRA (Manna Kumari)
Magneto-Transport in Advanced Semiconductor Heterostructsures.
Supervisor: Dr. O.P. Thakur, Dr. Rachna Manchanda and Dr. R.K. Sharma
Th 23078

Abstract
(Not Verified)

The thesis deals with emerging and contemporary issue of heterostructures which find application in mobile technology, satellite communication, radars etc. i.e. from civil to military applications. This work is the first ever successful attempt in establishing characterization facility of HEMT (High Electron Mobility Transistors) structures at SSPL, DRDO, Delhi, using Shubnikov de Haas(SdH) Oscillations. The thesis work centers on the quantum magnetotransport study of AlGaN/GaN HEMT structures comprising 2DEG at the interface. The comprehensive analysis includes the interpretation of experimental response of Longitudinal Magnetoresistance (R_{xx}) and Transverse Magnetoresistance or Hall Resistance (R_{xy}) measured as a function of temperature, T (ranging between 1.8 K and 300K) and perpendicular magnetic field, B (varied from 0-8 Tesla). The R_{xx}comprises both non-oscillatory part (Classical regime) and the oscillatory part called SdH Oscillations (Quantum-Mechanical regime). A general methodology of Fast Fourier Transform (FFT) smoothing was established for the isolation of oscillatory and non-oscillatory components of magnetoresistance curves. These periodic SdH oscillations play the most significant role by rendering three important parameters viz., carrier concentration, effective mass (m^*) and quantum scattering time (quantum mobility) of 2DEG. The estimation of dominating scattering mechanism has been studied through ratio of transport and quantum mobilities. Positive Magnetoresistance and Negative Magnetoresistance can be interpreted as the presence of parallel conduction and disorder (antidots and interface roughness in this case) respectively. The interface roughness parameters, multiple carriers' density and mobility, density of antidots have been quantitatively estimated The presence of beating pattern (due to Rashba effect in this case) in SdH oscillation indicated the utility of AlGaN/GaN HEMT structures in spintronics and the evaluation of spin parameters is done.

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03. SARITA RANI

Cosmology with Isotropic and Anisotropic Universe in Einstein and Modified Gravity Theories.

Supervisor: Dr. Jainendra Kumar Singh

Th 23035

Abstract
(Verified)

The spatially homogeneous and anisotropic cosmological models of the type Bianchi-I and Bianchi-III have been studied in Einstein general theory of relativity. Ordinary matter contents which include bulk viscous fluid, null radiation flow with perfect fluid have been used in these models. Further Bianchi type-I and Bianchi type-III models have been examined in modified gravity theories such as Lyra's geometry, f(R,T) gravity with baryonic as well as exotic matter content (Chaplygin gas). Various observational parameters have been evaluated to uncover mysterious folds of the universe. Subsequently Isotropic power law cosmological model has been explored to put the observational constraints on two significant cosmological parameters: the Hubble parameter H and the deceleration parameter q using H(z) data and Union 2.1 compilation data. Physical features of all the above models have been discussed. Statefinder diagnostic have been employed to characterize the different phases of the universe. Stability conditions of the models

have also been discussed. As a result of the above work, it has been observed that all the theoretical models discussed above have provided us remarkable results whether it be explaining the anisotropies present in the universe or it be describing the accelerating/decelerating phases in the universe. Observational constraints on the cosmological parameters have depicted that power-law cosmology is well tuned with Union2.1 compilation data but not with H(z) data. The above discussions provide platform for further exploration in Einstein and modified gravity theories in isotropic as well as anisotropic cosmologies. Studies done so far shed the light for further investigation in the field of cosmology in Einstein and modified gravity theories. The whole work has been published in the international journals: International Journal of Theoretical Physics (IJTP), Applied Mathematics and Computation (AMC) and Journal of Cosmology and Astroparticle Physics (JCAP).

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