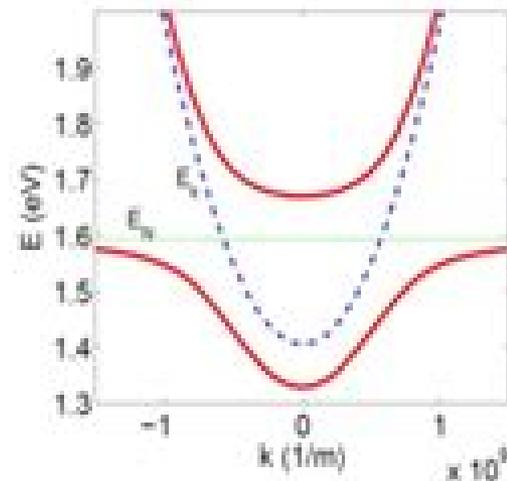


Dilute nitride semiconductors

- In dilute nitride materials, localised Nitrogen resonant states reduce the band gap energy, and effectively cause the conduction band to split into two non-parabolic sub-bands leading to flexible wavelength tailoring.
- Band Anti-Crossing (BAC) model provides a good basis to understand the electronic properties of nitride alloys.



Dispersion relation for $\text{GaN}_{0.005}\text{As}_{0.995}$
calculated by BAC model

Dilute Nitride Semiconductors

Amanuel Matewos Teweldeberhan



Dilute Nitride Semiconductors:

Dilute Nitride Semiconductors Mohamed Henini, 2004-12-15 This book contains full account of the advances made in the dilute nitrides providing an excellent starting point for workers entering the field It gives the reader easier access and better evaluation of future trends Conveying important results and current ideas Includes a generous list of references at the end of each chapter providing a useful reference to the III V N based semiconductors research community The high speed lasers operating at wavelength of 1.3 μm and 1.55 μm are very important light sources in optical communications since the optical fiber used as a transport media of light has dispersion and attenuation minima respectively at these wavelengths These long wavelengths are exclusively made of InP based material InGaAsP InP However there are several problems with this material system Therefore there has been considerable effort for many years to fabricate long wavelength laser structures on other substrates especially GaAs The manufacturing costs of GaAs based components are lower and the processing techniques are well developed In 1996 a novel quaternary material GaInAsN was proposed which could avoid several problems with the existing technology of long wavelength lasers In this book several leaders in the field of dilute nitrides will cover the growth and processing experimental characterization theoretical understanding and device design and fabrication of this recently developed class of semiconductor alloys They will review their current status of research and development Dilute Nitrides III N V Semiconductors Physics and Technology organises the most current available data providing a ready source of information on a wide range of topics making this book essential reading for all post graduate students researchers and practitioners in the fields of Semiconductors and Optoelectronics Contains full account of the advances made in the dilute nitrides providing an excellent starting point for workers entering the field Gives the reader easier access and better evaluation of future trends conveying important results and current ideas Includes a generous list of references at the end of each chapter providing a useful reference to the III V N based semiconductors research community

Dilute III-V Nitride Semiconductors and Material Systems Ayse Erol, 2008-01-12 A major current challenge for semiconductor devices is to develop materials for the next generation of optical communication systems and solar power conversion applications Recently extensive research has revealed that an introduction of only a few percentages of nitrogen into III V semiconductor lattice leads to a dramatic reduction of the band gap This discovery has opened the possibility of using these material systems for applications ranging from lasers to solar cells Physics and Technology of Dilute III V Nitride Semiconductors and Novel Dilute Nitride Material Systems reviews the current status of research and development in dilute III V nitrides with 24 chapters from prominent research groups covering recent progress in growth techniques experimental characterization of band structure defects carrier transport transport properties dynamic behavior of N atoms device applications modeling of device design novel optoelectronic integrated circuits and novel nitrogen containing III V materials

Theoretical Study of Local Defect Structures in Dilute Nitride Semiconductors John Anthony Buckeridge, 2010 The focus of this work is

an investigation of the local structure of nitrogen related defects in the dilute nitride semiconductor $\text{GaN}_x\text{As}_{1-x}$. Dilute nitride alloys have attracted considerable attention in recent years. When a small fraction of the As atoms in GaAs or InGaAs are replaced by N the energy gap of the material decreases rapidly for example by 150 meV when the N concentration is 1% making it a promising material for long wavelength 1.3 and 1.55 μm telecommunications lasers based on a GaAs substrate and for extending the wavelength range of GaAs based solar cells further into the infrared. However the addition of these small concentrations of nitrogen to GaAs has also been found to cause a drastic reduction in n type carrier mobility to such a degree as to render the materials unacceptable for many applications at present. The reductions in band gap and carrier mobility are attributed to an interaction between the GaAs conduction band and a set of localized or quasi localized defect states associated with the substitution of N on As sites at random throughout the alloy. The drastically low mobility in particular is attributed to the interaction with localized defect states associated with clusters of N atoms sharing Ga nearest neighbours with energies very close to the conduction band edge. We calculate methods of probing defects associated with substitutional N in GaAs. In particular we present results of first principles density functional theory calculations on the localized vibrational mode (LVM) spectrum of the Si-N defect in GaAs and the effects of strain on the isolated nitrogen LVM. A gated double quantum well InGaAs $\text{GaN}_x\text{As}_{1-x}$ heterostructure device in which the interaction between conduction band carriers and states associated with clusters of nitrogen atoms forming at random throughout the alloy can be tuned by varying the gating electric fields is described. The mobility as a function of gate field is calculated with reductions in mobility occurring when the Fermi level is resonant with the energies of the N cluster states providing a possible experimental method of probing these states which lie near the GaAs conduction band edge and are considered to be the primary mobility limiting factor in the dilute nitrides.

Hydrogenated Dilute Nitride Semiconductors Gianluca Ciatto, 2015-04-01. The nonlinear behavior of nitrogen and the passivation effect of hydrogen in dilute nitrides open the way to the manufacture of a new class of nanostructured devices with in plane variation of the optical band gap. This book addresses the modifications of the electronic structure and of the optical and structural properties induced in these technologically important semiconductors by atomic hydrogen irradiation. The book comprises discussions on experimental results from several techniques enriched by state of the art theoretical studies aimed at clarifying the origin of hydrogenation effects that lead to the discovery of specific nitrogen hydrogen complexes. It presents techniques such as infrared absorption spectroscopy, synchrotron radiation and nuclear reaction analysis which have indeed been crucial for addressing the physical origin of hydrogenation effects and their role in fine structural characterization. The book is not a simple assembly of the contributions of different groups on the subject; it rather tells the complete story of the amazing effects of hydrogen irradiation from the first observations to the discovery of their origin and to potential technology transfer. The primary scope of the book is to guide PhD students and new scientists into the field and to inspire similar analysis approaches in other fields. **The**

Investigation of Growth Parameters and Characterization of Dilute Nitride Semiconductors Sheng Chao,2009
Research and Development of Dilute Nitride Semiconductors GaInNAs-on-GaAs Emil-Mihai Pavelescu,2004
Physics and Applications of Dilute Nitrides I. Buyanova,W. Chen,2004-08-30 Since their development in the 1990s it has been discovered that diluted nitrides have intriguing properties that are not only distinct from those of conventional semiconductor materials but also are conducive to various applications in optoelectronics and photonics The book examines these applications and presents a broad and in depth look at t

Optical Characterization of Dilute Nitride Semiconductors and Related Quantum Structures Morteza Izadifard,2005 **Gain Studies of Dilute Nitride Semiconductor Materials** David J. Palmer,2006 *Investigation of Dilute Nitride Laser Degradation and Alternative N Sources for MBE Growth of III-V Dilute Nitride Semiconductors* Weisheng Lu,2009 Hydrogenated Dilute Nitride Semiconductors Gianluca Ciatto,2015-04-01 The nonlinear behavior of nitrogen and the passivation effect of hydrogen in dilute nitrides open the way to the manufacture of a new class of nanostructured devices with in plane variation of the optical band gap This book addresses the modifications of the electronic structure and of the optical and structural properties induced in these technol

Investigation of Dilute Nitride Laser Degradation and Alternative N Sources for MBE Growth of III-V Dilute Nitride Semiconductors Weisheng Lu,2009 *Compositional Analysis of Dilute Nitride Semiconductor Structures* Chris Lewis,2002 **Dilute Nitride Long Wavelength Semiconductor Diode Lasers** Xia Zhang,2007 *First-principles Study of Localized Vibrational Modes in Dilute Nitride Semiconductors* Amanuel Matewos Teweldeberhan,2007 Dilute nitride alloys GaNAs InGaNAs AlGaNAs have attracted considerable interest in the past few years both because of their unique physical properties and potential device applications When a small fraction of As atoms in these alloys are replaced by N the energy gap decreases rapidly for example by 150 meV when 1% of N is added to GaAs This makes the nitride alloys promising candidates for long wavelength 1.3 and 1.5 micron telecommunication lasers based on GaAs substrates and for extending the wavelength range of GaAs based solar cells further into the infrared Carrier transport in dilute nitride semiconductors is strongly affected by the type of nitrogen defects present Localized vibrational mode LVM spectroscopy is a useful technique for studying the local bonding of impurities and impurity complexes in semiconductors It can also be used for determining the type and concentration of defects in semiconductors Substantial experimental work using both Raman and Fourier transform infrared absorption FTIR spectroscopies has been done to study the LVM caused by the incorporation of N into GaAs InGaAs and AlGaAs However although first principles calculations of the equilibrium structure of the substitutional N in GaAs are available the dynamics of the LVM have not been investigated theoretically The aim of this thesis is to provide a theoretical understanding of the vibrational signature of various defects from first principles methods which will be useful in characterizing dilute nitride alloys by vibrational spectroscopy The LVMs associated with isolated N substitutional N N pair N N and N As split interstitials and N centered clusters in dilute nitride semiconductors

have been studied using first principles electronic structure theory methods and compared with available Raman and FTIR spectroscopy measurements. Models of high frequency modes are built from a linear combination of modes localized near each nitrogen atom to study the phonon spectra of substitutional nitrogen atoms in the random GaNAs alloy. Effects of Plasma Species During the Molecular-beam Epitaxy Growth of Dilute Nitride Semiconductors for Infrared Optoelectronic Device Applications Michael Mikio Oye, 2006

III-nitride Zhe Chuan Feng, 2006. III Nitride semiconductor materials Al In Ga N are excellent wide band gap semiconductors. This book presents the various developments and achievements in the field. It is useful for engineers, scientists, and students. *Novel Dilute Nitride Semiconductor Materials for Mid-infrared Applications* Aurelien Maxime Renaud Godenir, 2008

Nitrides and Dilute Nitrides Javier Miguel-Sánchez, 2007-01-01. Since the early developments of the last century, a lot of investigations and works have been devoted to the study of the science and technology of semiconductors. Although silicon and germanium were the pioneering semiconductors in the last years, the so-called III-V semiconductors B, Al, Ga, In, P, As, Sb attracted a lot of attention for their interesting properties: high mobility, direct transitions, which yielded to the successful development of high speed electronic devices and light emitting and laser diodes. Current telecom applications are mainly based in these semiconductor devices: mobile phones, VCSELs in fibre optic applications, etc. But in the last decades, the incorporation of the small and highly electronegative nitrogen atom in the old III-V semiconductors has opened a new and interesting field in semiconductor physics and applications. Nitrides III-N and dilute nitrides III-V-N are nowadays the main candidates for the development of devices with improved characteristics: laser diodes in the wavelengths of interest for telecom applications in the visible and UV range, high electron mobility transistors, white LED for automotive, home, and airplane illumination with much lower heat dissipation than bulb based illumination, high temperature applications. This book is devoted to a detailed compilation of comprehensive reviews of the main topics under investigation in the field of nitride and dilute nitrides, written by the pioneers and researchers from the leading research labs from all over the world, describing the properties of these semiconductors. From the ab initio theory to the growth, MOCVD, MBE, and characterization, magnetic, electric, structural of the materials and the devices.

Investigation of the Optical and Electrical Properties of Dilute Nitride Compound Semiconductors Based on GaP. Hind Mohammed Albalawi, 2019

The Enigmatic Realm of **Dilute Nitride Semiconductors**: Unleashing the Language is Inner Magic

In a fast-paced digital era where connections and knowledge intertwine, the enigmatic realm of language reveals its inherent magic. Its capacity to stir emotions, ignite contemplation, and catalyze profound transformations is nothing lacking extraordinary. Within the captivating pages of **Dilute Nitride Semiconductors** a literary masterpiece penned by a renowned author, readers set about a transformative journey, unlocking the secrets and untapped potential embedded within each word. In this evaluation, we shall explore the book's core themes, assess its distinct writing style, and delve into its lasting impact on the hearts and minds of those that partake in its reading experience.

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