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**Investigations on the Characterization of Ion Implanted Hexagonal Boron Nitride Insitu Ion Implantation Beneath Boron Nitride Nanomesh** Swift Heavy Ion Irradiated Boron Nitride with and Without Application of High Pressure *Investigation of Silicon Nitride Formed by Low-energy Ion-implantation Low-Energy Sputtering Studies of Boron Nitride with Xenon Ions* Formation of Aluminium Nitride by Plasma Immersion Ion Implantation **Ion Assisted Sputter Deposition and Structural Characterization of Cubic Boron Nitride** *III-Nitride Ion Implantation and Device Processing* **Ion Implantation Into Gallium Nitride** Boron Nitride Nanomaterials Engergetic Ion-based Deposition and Implantation of Metal-nitride Diffusion Barriers for Microelectrics Applications by Plasma Source Ion Implantation **Effect of Low Temperature Ion Irradiation on the Microstructure of Nitride Ceramics Residual Stresses in Cubic Boron Nitride Thin Films Deposited by Ion-assisted Laser Ablation** Ion Implantation in Gallium Nitride *Ion Beam-assisted Deposition of Boron Nitride from a Condensed Layer of Diborane and Ammonia at 78 K. Sputtering investigation of boron nitride with xenon ion* **Fundamental tribological properties of ion-beam-deposited boron nitride films Ion-assisted Chemical Vapor Deposition of Thin Film Cubic Boron Nitride Nucleation and Growth of Ion-beam-deposited Cubic Boron Nitride Thin Films** Characterization of Silicon-nitride-silicon Structure Formed by Nitrogen Ion Implantation in Silicon Characterization of Nanostructured Hexagonal Boron Nitride Patterned Via High-resolution Ion Beam Lithography **Ion Implantation in Gallium Nitride Aluminum Nitride Films Produced by Ion Sputtering Preparation of Diamond-like Carbon and Boron Nitride Films by High-intensity Pulsed Ion Beam Deposition** *Investigations of the Ion Beam Assisted Deposition of a Thin Boron Nitride Film from Condensed Diborane and Ammonia Synthesis and Characterisation of Titanium Nitride Films Using a Dual Ion Beam Technique* Synthesis of Metastable Carbon-silicon Nitride by Non-equilibrium Processing *Ion Induced Stress Relaxation During the Growth of Cubic Boron Nitride Thin Films Optical Properties of Ion-implanted Impurities in Gallium Nitride* Modification of Amorphous Silicon Nitride Surfaces by Ion Implantation of Gallium **Ion Bombardment of the Silicon Nitride-silicon Interface** Deposition of Reactively Ion Beam Sputtered Silicon Nitride Coatings Ion-beam Processes in Group-III Nitrides *Nanotubes and Nanosheets* Recombination and Photosensitivity Centres in Boron Nitride Irradiated with Ions *Synthesis and Properties of Boron Nitride* **The Properties of Titanium Nitride Coatings Produced by Reactive Ion Plating The Development of Ion Plated Titanium Nitride Coatings for Metal Forming Tools** *Ion-induced Stress Relaxation During the Growth of Cubic Boron Nitride Thin Films* **Total and Differential Sputter Yields of Boron Nitride Measured by Quartz Crystal Microbalance (Preprint).**

The forefront of polariton research in two-dimensional (2D) materials focuses on pushing the limits of patterning 2D materials into nanoresonators and other nanophotonic structures that manipulate highly confined polaritons for technologically relevant near-IR and mid-IR applications. Furthermore, tuning the properties of hexagonal boron nitride, graphene, and other 2D materials in-plane and stacking them into heterostructures has the potential to create hybrid optical, electronic, thermal, and mechanical properties with a wealth of new functions. To fully tailor these novel properties, controlled nanoscale patterning of these and other van der Waals materials is essential. Moreover, it becomes imperative to understand how patterning and geometries modify the properties within each layer or introduce defects that affect the interfaces of layered 2D heterostructures. Herein, we demonstrate high-resolution patterning of h-BN via both helium and neon ion beams and pattern a h-BN grating with a 35 nm pitch and 20 nm feature size. We study varying degrees of nanostructuring and defects via Raman spectroscopy, photo-thermal microscopy, and scattering-type scanning near-field optical microscopy and observe complimentary information about the phonon modes and the absorption and scattering of light from such nanostructures. Specifically, we observe geometry and layer dependent photo-thermal expansion of h-BN nanostructures that are mediated by phonons. This work demonstrates a thorough understanding of directly patterned 2D materials with ion beams and demonstrates that far-field and near-field measurements are essential in understanding how the nanostructuring of 2D materials can tune their properties. Boron nitride thin films can be deposited on different substrates using techniques such as plasma deposition, ion beam deposition and reactive sputter deposition. "Group-III-nitride semiconductors (GaN, InGaN, and AlGaN) are important for the fabrication of a range of optoelectronic devices (such as blue-green light emitting diodes, laser diodes, and UV detectors) as well as devices for high-temperature/high-power electronics. In the fabrication of these devices, ion bombardment represents a very attractive technological tool. However, a successful application of ion implantation depends on an understanding of the effects of radiation damage. Hence, this thesis explores a number of fundamental aspects of radiation effects in wurtzite III-nitrides. Emphasis is given to an understanding of (i) the evolution of defect structures in III-nitrides during ion irradiation and (ii) the influence of ion bombardment on structural, mechanical, optical, and electrical properties of these materials. ... The work presented in this thesis has resulted in the identification and understanding of a number of both fundamental and technologically important ion-beam processes in III-nitrides. Most of the phenomena investigated are related to the nature and effects of implantation damage, such as lattice amorphization, formation of planar defects, preferential surface disordering, porosity, decomposition, and quenching of CL. These effects are often technologically undesirable, and the work of this thesis has indicated, in some cases, how such effects can be minimized or controlled. However, the thesis has also investigated one example where irradiation-produced defects can be successfully applied for a technological benefit, namely for electrical isolation of GaN-based devices. Finally, results of this thesis will clearly stimulate further research both to probe some of the mechanisms for unusual ion-induced effects and also to develop processes to avoid or repair unwanted lattice damage produced by ion bombardment." We present differential sputter yield measurements of boron nitride due to bombardment by xenon ions. A four-grid ion optics system is used to achieve a collimated ion beam at low energy ( The aim of the presented work was to deposit cubic boron nitride thin films by magnetron sputtering under simultaneous stress relaxation by ion implantation. An in situ instrument based on laser deflectometry on cantilever structures and in situ ellipsometry, was used for in situ stress measurements. The characteristic evolution of the instantaneous stress during the layered growth of cBN films observed in IBAD experiments, could be reproduced for magnetron sputter deposition. To achieve simultaneous stress relaxation by ion implantation, a complex bipolar pulsed substrate bias source was constructed. This power supply enables the growth of cBN thin films under low energy ion irradiation (up to 200 eV) and, for the first time, the simultaneous implantation of ions with an energy of up to 8 keV during high voltage pulses. It was demonstrated that the instantaneous stress in cBN thin films can be released down to -1.1 GPa by simultaneous ion bombardment during the high voltage pulses. A simultaneous stress relaxation during growth is possible in the total investigated ion energy range between 2.5 and 8 keV. These are the lowest ion energies reported for the stress relaxation in cBN. Since such a substrate bias power supply is easy to integrate in existing process lines, this result is important for industrial deposition of thin films, not only for cubic boron nitride films. It was found that the amount of stress relaxation depends on the number of atomic displacements (displacements per atom: dpa) that are induced by the high energy ion bombardment and is therefore dependent on the ion energy and the high energy ion flux. In practise, this means that the stress relaxation is controlled by the product of the pulse voltage and the pulse duty cycle or frequency. The cantilever bending measurements were complemented on microscopic scale by x-ray diffraction (XRD). The analysis of the cBN (111) lattice distances revealed a pronounced biaxial compressive state of stress in. Boron nitride was first produced in the 18th century and, by virtue of its extraordinary mechanical strength, has found extensive application in industrial processes since the 1940s. However, the more recent discovery that boron nitride allotropes are as structurally diverse as those of carbon (e.g. fullerenes, graphene, carbon nanotubes) has placed this material, and particularly its low-dimensional allotropes, back at the forefront of modern material science. This book provides a comprehensive history of this rapid rise in the status of boron nitride and boron nitride nanomaterials, spanning the earliest examples of three-dimensional boron nitride allotropes, through to contemporary structures such as monolayer hexagonal boron nitride, boron nitride nanomeshes, boron nitride nanotubes and the incorporation of boron nitride into cutting-edge van der Waals heterostructures. It specifically focuses on the properties, applications and synthesis techniques for each of these allotropes and examines how the evolution in boron nitride production methods is linked to that in our understanding of how low-dimensional nanomaterials self-assemble, or ‘grow’, during synthesis. The book demonstrates the key synergy between growth mechanisms and the development of new, advanced nanostructured materials. Cross-section transmission electron microscopy was used to investigate the microstructure of polycrystalline silicon nitride (Si3N4) and aluminum nitride (AlN) following 2 MeV Si ion irradiation at 80 and 400 K up to a fluence of 4 x 102° ions/m2 (maximum damage of (approximately)10 displacements per atom, dpa). A buried amorphous band was observed at both temperatures in Si3N4 in the region corresponding to the peaks in the implanted ion and displacement damage. From a comparison of Si3N4 specimens irradiated at different fluences, it is concluded that the amorphization is primarily controlled by the implanted Si concentration rather than the displacement damage level. Si3N4 amorphization did not occur in regions well-separated from the implanted ions for doses up to at least 3 dpa at 80 K, whereas amorphization occurred in the ion implanted region (calculated Si concentration>0.01 at.%) for damage levels as low as (approximately)0.6 dpa. The volumetric swelling associated with the amorphization of Si3N4 is This paper examines the ion beam-assisted deposition (IBAD) of thin boron nitride films using cryogenically condensed precursors. Low energy (1100 eV) argon ad (2000 eV) deuterated ammonia beams with currents of 600--850 nA were used to mix and initiate reactions in frozen (90 K) layers of diborane (B2H6 and ammonia (NH3) or only B2H6, respectively. The resulting film is shown to be an amorphous BN coating approximately 30 Å thick. Reveals Innovative Research on BN Nanotubes and Nanosheets Nanotubes and Nanosheets: Functionalization and Applications of Boron Nitride and Other Nanomaterials is the first book devoted to nanotubes and nanosheets made of boron nitride (BN). It shows how the properties of BN nanotubes and nanosheets have led to many exciting applications where carbon (C) materials cannot be used, including high-temperature metal-ceramic-based composites, substrates for graphene and other semiconducting layers in electronic devices, reusable absorbents for oil and other contaminants, dry solid lubricants, and biomedical applications. Researchers working on various aspects of BN nanomaterials share their knowledge and current work on the applications of BN nanotubes and nanosheets. They describe numerous applications, including BN nanotube-reinforced metal-ceramic-based composites, field emission, desalination, cleanup of oil spillages, biosensing and bioimaging, drug delivery, biomedical applications, and energy storage using BCN and TiO2 nanorods and nanosheets as electrode materials. The book also covers C and other nanotubes and nanosheets to give readers a broad view of the latest nanomaterials research.

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