

Review Paper

Filament-activated Chemical Vapour Deposition of Nitride Thin FilmsSadanand V. Deshpande,¹ Jeffrey L. Dupuis,¹ and Erdogan Guler²

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We have applied the novel method of hot filament-activated chemical vapour deposition (HPCVD) for low-temperature deposition of a variety of nitride thin films. In this paper the results from our recent work on aluminium, silicon and titanium nitride have been reviewed. In the HPCVD method a hot tungsten filament (1500–1650 °C) was utilized to decompose ammonia in order to deposit nitride films at low substrate temperatures and high rates. The substrate temperatures ranged from 245 to 600 °C. The film properties were characterised by a number of analytical and optical methods. The effect of various deposition conditions on film properties was studied. All the films obtained were of high chemical purity and had very low or no detectable tungsten contamination from the filament metal.

KEYWORDS: hot filament chemical vapour deposition; CVD; high-rate deposition; ammonia; silicon nitride; aluminium nitride; titanium nitride

INTRODUCTION

Hot filament-activated chemical vapour deposition (HPCVD) is a simple and a relatively inexpensive method that has been used to deposit a variety of materials. In this method a resistively heated filament (tungsten, rhenium or tantalum) is used to thermally and/or catalytically dissociate one or more of the source gas molecules to produce reactive precursors needed to form the desired film. One of the most attractive features of the HPCVD approach is that the thermal activation of reactants is decoupled from the film growth step at the substrate. This simple approach allows for deposition at low substrate temperatures (from room temperature to 400 °C). High film deposition rates can be obtained by appropriately adjusting the deposition conditions. Using proper reactor

design and operating regimes, films with varied properties can be deposited with little or no contamination from reactions at the reactor walls as is found in other techniques such as plasma-assisted chemical vapour deposition.

HPCVD has been extensively used for over a decade to deposit polycrystalline diamond thin films.^{1–3} Polycrystalline diamond has been deposited on a number of different non-diamond substrates using a variety of carbon-containing gases and under varying conditions in a hot filament system. However, typical conditions under which good quality, highly faceted diamond is obtained are: filament temperature, 2000–2200 °C; filament-to-substrate distance, 1.0 cm; substrate temperature, 800–1000 °C; reactor pressure, 20–30 Torr; gas composition, 0.5% CH₄ in hydrogen. This simple technique has provided great insight into the process chemistry and the mechanism of diamond

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Reza Fazel-Rezai

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Handbook of Surfaces and Interfaces of Materials, Five-Volume Set Hari Singh Nalwa, 2001-10-26 This handbook brings together under a single cover all aspects of the chemistry physics and engineering of surfaces and interfaces of materials currently studied in academic and industrial research It covers different experimental and theoretical aspects of surfaces and interfaces their physical properties and spectroscopic techniques that have been applied to a wide class of inorganic organic polymer and biological materials The diversified technological areas of surface science reflect the explosion of scientific information on surfaces and interfaces of materials and their spectroscopic characterization The large volume of experimental data on chemistry physics and engineering aspects of materials surfaces and interfaces remains scattered in so many different periodicals therefore this handbook compilation is needed The information presented in this multivolume reference draws on two decades of pioneering research on the surfaces and interfaces of materials to offer a complete perspective on the topic These five volumes Surface and Interface Phenomena Surface Characterization and Properties Nanostructures Micelles and Colloids Thin Films and Layers Biointerfaces and Applications provide multidisciplinary review chapters and summarize the current status of the field covering important scientific and technological developments made over past decades in surfaces and interfaces of materials and spectroscopic techniques with contributions from internationally recognized experts from all over the world Fully cross referenced this book has clear precise and wide appeal as an essential reference source long due for the scientific community The complete reference on the topic of surfaces and interfaces of materials The information presented in this multivolume reference draws on two decades of pioneering research Provides multidisciplinary review chapters and summarizes the current status of the field Covers important scientific and technological developments made over past decades in surfaces and interfaces of materials and spectroscopic techniques Contributions from internationally recognized experts from all over the world

Tin Chemistry Marcel Gielen, 2008-09-15 Tin chemistry retains a place in contemporary science as an important element owing to its wide range of applications New and exciting research is being generated on an annual basis from all parts of the world the study of tin and its compounds attracts considerable interest from a range of perspectives such as organic synthesis medicine materials chemistry catalysis and environment Tin Chemistry Fundamentals Frontiers and Applications collects in one comprehensive volume authoritative and concise snapshots of modern tin chemistry in a full range of applications Over forty of the leading tin chemistry experts have contributed reviews in six themes fundamentals in tin chemistry materials chemistry and structural chemistry of tin compounds medicinal and biocidal applications of tin compounds tin in the environment tin in organic synthesis tin in catalysis Tin Chemistry Fundamentals Frontiers and Applications is an essential overview of modern perspectives on this important element for the specialist and non specialist alike It will promote cross disciplinary interactions and at the same time be an essential teaching resource for advanced university classes

Thin

Films by Chemical Vapour Deposition C.E. Morosanu, 2016-06-22 The explosive growth in the semiconductor industry has caused a rapid evolution of thin film materials that lend themselves to the fabrication of state of the art semiconductor devices. Early in the 1960s an old research technique named chemical vapour phase deposition CVD which has several unique advantages developed into the most widely used technique for thin film preparation in electronics technology. In the last 25 years tremendous advances have been made in the science and technology of thin films prepared by means of CVD. This book presents in a single volume an up to date overview of the important field of CVD processes which has never been completely reviewed previously.

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heterostructures Quantum wells superlattices monolayers two dimensional electron gases Part V 17 Present and Future Importance of CVD Films **Kirk-Othmer Encyclopedia of Chemical Technology, Volume 23** Kirk-Othmer,2006-11-10 The fifth edition of the Kirk Othmer Encyclopedia of Chemical Technology builds upon the solid foundation of the previous editions which have proven to be a mainstay for chemists biochemists and engineers at academic industrial and government institutions since publication of the first edition in 1949 The new edition includes necessary adjustments and modernization of the content to reflect changes and developments in chemical technology **Solid State Science and Technology IV** Nay Ming Huang,Saadah Abd Rahman,Kai Lin Woon,2014-02-13 Selected peer reviewed papers from the 4th International Conference on Solid State Science and Technology ICSSST 2012 December 18 20 2012 Melaka Malaysia **Surface Engineering Series Volume 2: Chemical Vapor Deposition** Edited by Jong-Hee Park and T.S. Sudarshan,2000-05-01 This handbook provides guidelines and practical information on the chemical vapor deposition CVD process for surface engineering design product development and manufacturing The first of the 14 chapters discuss the basic principles of CVD thermodynamics and kinetics stresses and mechanical sta **Biomedical Engineering** Reza Fazel-Rezai,2011-08-29 In all different areas in biomedical engineering the ultimate objectives in research and education are to improve the quality life reduce the impact of disease on the everyday life of individuals and provide an appropriate infrastructure to promote and enhance the interaction of biomedical engineering researchers This book is prepared in two volumes to introduce a recent advances in different areas of biomedical engineering such as biomaterials cellular engineering biomedical devices nanotechnology and biomechanics It is hoped that both of the volumes will bring more awareness about the biomedical engineering field and help in completing or establishing new research areas in biomedical engineering *Handbook of Surfaces and Interfaces of Materials: Solid thin films and layers* Hari Singh Nalwa,2001 **Silicon Carbide** Moumita Mukherjee,2011-10-10 Silicon Carbide SiC and its polytypes used primarily for grinding and high temperature ceramics have been a part of human civilization for a long time The inherent ability of SiC devices to operate with higher efficiency and lower environmental footprint than silicon based devices at high temperatures and under high voltages pushes SiC on the verge of becoming the material of choice for high power electronics and optoelectronics What is more important SiC is emerging to become a template for graphene fabrication and a material for the next generation of sub 32nm semiconductor devices It is thus increasingly clear that SiC electronic systems will dominate the new energy and transport technologies of the 21st century In 21 chapters of the book special emphasis has been placed on the materials aspects and developments thereof To that end about 70% of the book addresses the theory crystal growth defects surface and interface properties characterization and processing issues pertaining to SiC The remaining 30% of the book covers the electronic device aspects of this material Overall this book will be valuable as a reference for SiC researchers for a few years to come This book prestigiously covers our current understanding of SiC as a semiconductor material in electronics The primary target for the

book includes students researchers material and chemical engineers semiconductor manufacturers and professionals who are interested in silicon carbide and its continuing progression Subject Guide to Books in Print ,1993 Engineered Materials Handbook: Ceramics and glasses ,1987 IETE Journal of Research ,1997 **Functional Materials and Devices** A. K. Arof,S. A. Hashim Ali,2006 The last five decades have seen an explosion of interest in exploring the possibilities of new materials for industrial and commercial applications Materials Technology is now recognized as being one of the most important factors driving the development and growth of a nation s economy The sciences of design processing manufacturing and materials utilization are crucial elements contributing to the growth of new industries The need for new discoveries in Materials Science has encouraged scientists from around the world to meet regularly and to discuss the latest advances and innovations *Smart Materials & Micro/Nanosystems* Pietro Vincenzini, Giuseppe D'Arrigo, 2008-09-02 CIMTEC 2008 Selected peer reviewed papers from the Symposium A Smart Materials Micro Nanosystems of CIMTEC 2008 3rd International Conference Smart Materials Structures and Systems held in Acireale Sicily Italy June 8 13 2008 **Encyclopedia of Optical Engineering: Pho-Z, pages 2049-3050** Ronald G. Driggers,2003 Compiled by 330 of the most widely respected names in the electro optical sciences the Encyclopedia is destined to serve as the premiere guide in the field with nearly 2000 figures 560 photographs 260 tables and 3800 equations From astronomy to x ray optics this reference contains more than 230 vivid entries examining the most intriguing technological advances and perspectives from distinguished professionals around the globe The contributors have selected topics of utmost importance in areas including digital image enhancement biological modeling biomedical spectroscopy and ocean optics providing thorough coverage of recent applications in this continually expanding field **Controlled Synthesis of Diamond Films Using a Microwave Discharge (non-equilibrium Plasma)** Saeid Khatami,1997 **Physics Briefs** ,1993 Journal of Thermophysics and Heat Transfer ,1998 This journal is devoted to the advancement of the science and technology of thermophysics and heat transfer through the dissemination of original research papers disclosing new technical knowledge and exploratory developments and applications based on new knowledge It publishes papers that deal with the properties and mechanisms involved in thermal energy transfer and storage in gases liquids and solids or combinations thereof These studies include conductive convective and radiative modes alone or in combination and the effects of the environment Proceedings ,1994 Modified Electrodes Allen J. Bard, Martin Stratmann, Masamichi Fujihira, Israel Rubinstein, James F. Rusling, 2007 Electrochemical processes play an increasingly large role in our daily lives whether in producing or saving energy rust protection or nerve stimuli in our bodies This 11 volume encyclopedia provides both an easy introduction to all topics related to modern electrochemistry as well as a comprehensive overview of the subject Unrivalled in its breadth and depth this first class reference work has been created and written by renowned scientists covering everything from fundamental research to areas of application Editors in Chief Allen Bard Martin Stratmann Volume 1 Thermodynamics and

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