

Review Paper

Filament-activated Chemical Vapour Deposition of Nitride Thin Films

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We have applied the novel method of hot filament-activated chemical vapour deposition (HFCVD) 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 HFCVD method a hot tungsten filament (1500–1850°C) was utilised 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 (HFCVD) 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 HFCVD 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.

HFCVD 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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Thin Film Deposition Techniques Tahir Iqbal Awan, Sumera Afsheen, Sabah Kausar, 2025-01-02 This book describes the basics and historical aspects of thin film. The introductory chapter of this book contains various aspects about thin film deposition methods, significance of nanomaterials in the fabrication of thin film, certain fundamental characteristics of thin films, electrical, optical, and morphological, some challenges, thickness, uniformity, film adhesion, issues, temperature related challenges, film defects, and quality control, preparation of the surface of the substrate before deposition etc. faced during the formation of thin film, significance and different types of deposition techniques along with their basic introduction, working principle, construction, merits, demerits, and also application in specific fields. This book specifically works on the techniques of thin film deposition and role of the thin film in the formation of these deposition methods. *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. 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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Part V 17 Present and Future Importance of CVD Films

Kirk-Othmer Chemical Technology and the Environment, 2 Volume Set Wiley, 2007-05-21 The two volume reference work Chemical Technology and the

Environment provides readers with knowledge on contemporary issues in environmental pollution prevention and control as well as regulatory health and safety issues as related to chemical technology. It introduces and expands the knowledge on emerging green materials and processes and greener energy technology as well as more general concepts and methodology including sustainable development and chemistry and green chemistry. Based on Wiley's renowned Kirk Othmer Encyclopedia of Chemical Technology, this compact reference features the same breadth and quality of coverage and clarity of presentation found in the original.

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.

19th Annual Conference on Composites, Advanced Ceramics, Materials, and Structures - A, Volume 16, Issue 4 John B. Wachtman, 2009-09-28 This volume is part of the Ceramic Engineering and Science Proceeding CESP series. This series contains a collection of papers dealing with issues in both traditional ceramics, i.e. glass, whitewares, refractories, and porcelain enamel, and advanced ceramics. Topics covered in the area of advanced ceramic include bioceramics, nanomaterials, composites, solid oxide fuel cells, mechanical properties, and structural design, advanced ceramic coatings, ceramic armor, porous ceramics, and more.

Metal Oxide Nanocomposite Thin Films for Optoelectronic Device Applications Rayees Ahmad Zargar, 2023-10-10 METAL OXIDE NANOCOMPOSITE THIN FILMS FOR OPTOELECTRONIC DEVICE APPLICATIONS The book provides insight into the fundamental aspects, latest research, synthesis route, development, preparation, and future applications of metal oxide nanocomposite thin films. The fabrication of thin film-based materials is important to the future production of safe, efficient, and affordable energy, as the devices convert sunlight into electricity. Thin film devices allow excellent interface engineering for high performance, printable solar cells, as their structures are highly reliable, and stand-alone systems can provide the required megawatts. They have been used as power sources in solar home systems, remote buildings, water pumping, megawatt-scale power plants, satellites, communications, and space vehicles. *Metal Oxide Nanocomposite Thin Films for Optoelectronic Device Applications* covers the basics of advanced nanometal oxide-based materials, their synthesis, characterization, and applications, and all the updated information on optoelectronics. Topics

discussed include the implications of metal oxide thin films which are critical for device fabrications It provides updated information on the economic aspect and toxicity with great focus paid to display applications and covers some core areas of nanotechnology which are particularly concerned with optoelectronics and the available technologies The book concludes with insights into the role of nanotechnology and the physics behind photovoltaics Audience The book will be an important volume for electronics and electrical engineers nanotechnologists materials scientists inorganic chemists in academic research and those in industries exploring the applications of nanoparticles in semiconductors power electronics and more

MES 24: Electrochemical Applications to Biology, Nanotechnology, and Environmental Engineering and Materials Manuel Eduardo Palomar Pardavé, 2009-11 This issue of ECS Transactions ECST comprises a selection of papers presented at the 24th national meeting of the Mexican Electrochemical Society MES and the second meeting of the Mexican Section of The Electrochemical Society ECS carried out in Puerto Vallarta Jalisco from May 31 to June 5 2009 **Emerging Semiconductor Technology** Dinesh C. Gupta, Paul H. Langer, 1987 **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 *Thin Film Coatings* Fredrick Madaraka Mwema, Tien-Chien Jen, Lin Zhu, 2022-06-19 Thin Film Coatings Properties Deposition and Applications discusses the holistic subject of conventional and emerging thin film technologies without bias to a specific technology based on the existing literature It covers properties and delves into the various methods of thin film deposition including the most recent techniques and a direction for future developments It also discusses the cutting edge applications of thin film coatings such as self healing and smart coatings biomedical hybrid and scalable thin films Finally the concept of Industry 4 0 in thin film coating technology is examined This book Explores a wide range and is not specific to material and method of deposition Demonstrates the application of thin film coatings in nearly all sectors such as energy and anti microbial applications Details the preparation and properties of hybrid and scalable ultra thin materials for advanced applications Provides detailed bibliometric analyses on applications of thin film coatings Discusses Industry 4 0 and 3D printing in thin film technology With its broad coverage this comprehensive reference will appeal to a wide audience of materials scientists and engineers and others studying and developing advanced thin film technologies **Handbook of Lubrication and Tribology, Volume II** Robert W. Bruce, 2012-07-06 Since the publication of the best selling first edition the growing price and environmental cost of energy have increased the significance of tribology Handbook of Lubrication and Tribology Volume II Theory and Design Second Edition demonstrates how the principles of tribology can address cost savings energy conservation and environmental pr Advanced Ceramic Coatings and Interfaces II, Volume 28, Issue 3 Uwe Schulz, Hua-Tay Lin, 2007-11-16 Papers from The American Ceramic Society's 31st International Conference on Advanced Ceramics and Composites held in Daytona Beach Florida January 21 26 2007 Focuses on recent advances in coating development processing structural design

microstructure and property characterization and life prediction Microwave Discharges Carlos M. Ferreira, Michel Moisan, 2013-11-21 Proceedings of a NATO ARW held in Vimeiro Portugal May 11 15 1992 **Thin-Film Silicon Solar Cells** Arvind Victor Shah, 2010-08-19 Photovoltaic technology has now developed to the extent that it is close to fulfilling the vision of a solar energy world as devices based on this technology are becoming efficient low cost and durable This book provides a comprehensive treatment of thin film silicon a prevalent PV material in terms of its semiconductor nature starting

Controlled Synthesis of Diamond Films Using a Microwave Discharge (non-equilibrium Plasma) Saeid Khatami, 1997 **Chemical Vapor Deposition** Jong-Hee Park, T. S. Sudarshan, 2001 **'Advances in Microelectronics: Reviews', Vol_1** Sergey Yurish, 2017-12-24 The 1st volume of Advances in Microelectronics Reviews Book Series contains 19 chapters written by 72 authors from academia and industry from 16 countries With unique combination of information in each volume the Advances in Microelectronics Reviews Book Series will be of value for scientists and engineers in industry and at universities In order to offer a fast and easy reading of the state of the art of each topic every chapter in this book is independent and self contained All chapters have the same structure first an introduction to specific topic under study second particular field description including sensing applications Each of chapter is ending by well selected list of references with books journals conference proceedings and web sites This book ensures that readers will stay at the cutting edge of the field and get the right and effective start point and road map for the further researches and developments **Ceramic Coatings** Feng Shi, 2012-02-24 The main target of this book is to state the latest advancement in ceramic coatings technology in various industrial fields The book includes topics related to the applications of ceramic coating covers in engineering including fabrication route electrophoretic deposition and physical deposition and applications in turbine parts internal combustion engine pigment foundry etc *Sputtered Thin Films* Frederick Madaraka Mwema, Esther Titilayo Akinlabi, Oluseyi Philip Oladijo, 2021-04-12 Sputtered Thin Films Theory and Fractal Descriptions provides an overview of sputtered thin films and demystifies the concept of fractal theory in analysis of sputtered thin films It simplifies the use of fractal tools in studying the growth and properties of thin films during sputtering processes Part 1 of the book describes the basics and theory of thin film sputtering and fractals Part 2 consists of examples illustrating specific descriptions of thin films using fractal methods Discusses thin film growth structure and properties Covers fractal theory Presents methods of fractal measurements Offers typical examples of fractal descriptions of thin films grown via magnetron sputtering processes Describes application of fractal theory in prediction of thin film growth and properties This reference book is aimed at engineers and scientists working across a variety of disciplines including materials science and metallurgy as well as mechanical manufacturing electrical and biomedical engineering

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