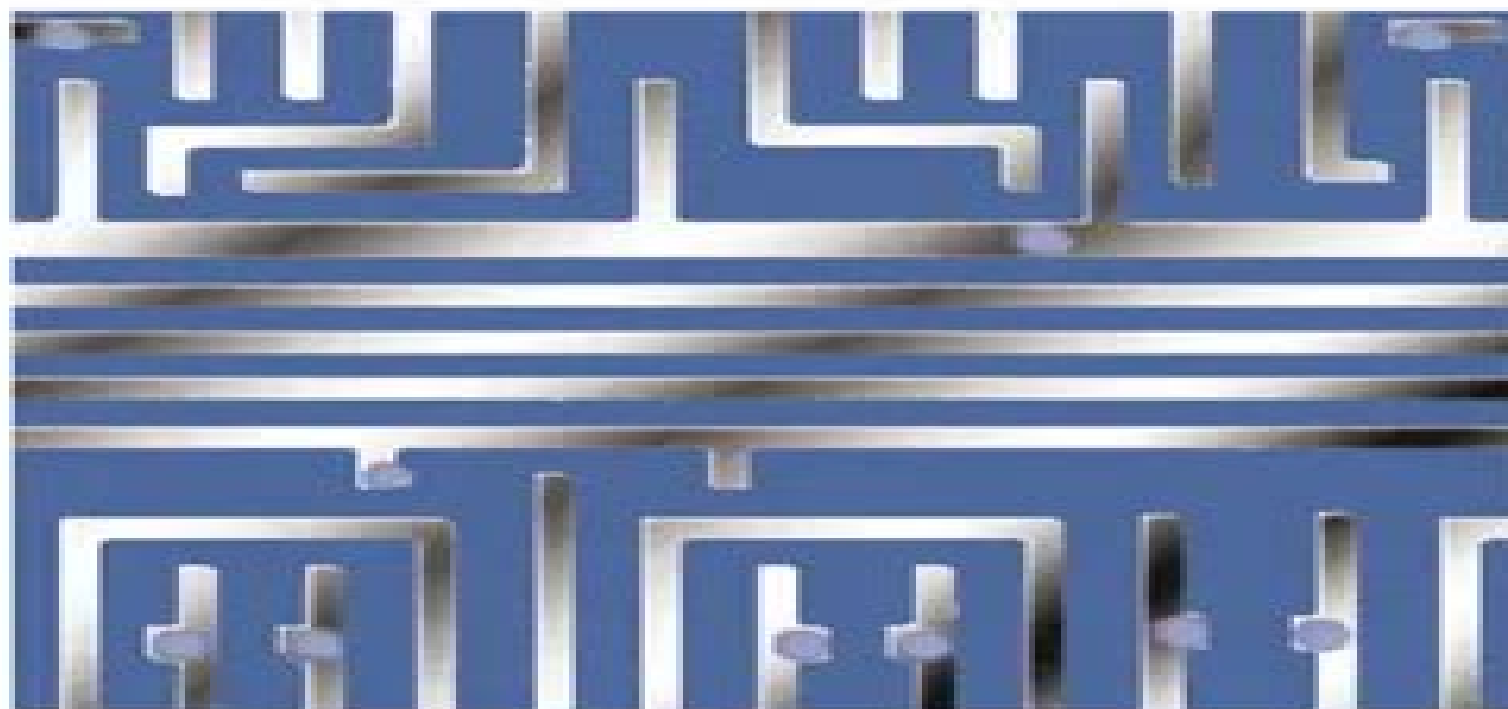


Joseph M. Steigerwald,  
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# Chemical Mechanical Planarization of Microelectronic Materials



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**Joseph M. Steigerwald, Shyam P.  
Murarka, Ronald J. Gutmann**



## **Chemical Mechanical Planarization Of Microelectronic Materials:**

**Chemical Mechanical Planarization of Microelectronic Materials** Joseph M. Steigerwald, Ronald J. Gutmann, Shyam P. Murarka, 2004 *Chemical Mechanical Planarization of Microelectronic Materials* Joseph M. Steigerwald, Shyam P. Murarka, Ronald J. Gutmann, 1997 The concluding chapter describes post CMP cleaning techniques and most chapters feature problem sets to assist readers in developing a more practical understanding of CMP The only comprehensive reference to one of the fastest growing integrated circuit manufacturing technologies Chemical Mechanical Planarization of Microelectronic Materials is an important resource for research scientists and engineers working in the microelectronics industry **Chemical Mechanical Planarization Of Microelectronic Materials** J.M. Steigerwald,

*Chemical-Mechanical Planarization of Semiconductor Materials* M.R. Oliver, 2013-03-14 Chemical Mechanical Planarization CMP has emerged in the last two decades and grown rapidly as a basic technology widely used in semiconductor device fabrication As a semiconductor processing step it was developed at IBM in the mid 1980s From this beginning the technology has been widely adopted throughout the semiconductor industry As basic CMP technology has been understood and accepted throughout the semiconductor industry its uses in different parts of the semiconductor process have multiplied This includes special steps for some special process ing flows such as for DRAM technology In addition the availability of CMP technology has enabled the implementation of new technologies with the best example being copper interconnect technology Copper could not be practi cally implemented into semiconductor process flows until the advent of CMP Unfortunately the rapid acceptance and implementation of CMP technol ogy in wafer fabrication has occurred without a corresponding rate of advance in the underlying science Progress is being made in understanding the un derlying CMP mechanisms but in general it is slow and uneven The most noteworthy exception to this trend is the science of metal CMP reactions where the scientific understanding is actually driving much of the advance of the technology There has been no corresponding progress in other CMP areas however Microelectronic Applications of Chemical Mechanical Planarization Yuzhuo Li, 2008 An authoritative systematic and comprehensive description of current CMP technology Chemical Mechanical Planarization CMP provides the greatest degree of planarization of any known technique The current standard for integrated circuit IC planarization CMP is playing an increasingly important role in other related applications such as microelectromechanical systems MEMS and computer hard drive manufacturing This reference focuses on the chemical aspects of the technology and includes contributions from the foremost experts on specific applications After a detailed overview of the fundamentals and basic science of CMP Microelectronic Applications of Chemical Mechanical Planarization Provides in depth coverage of a wide range of state of the art technologies and applications Presents information on new designs capabilities and emerging technologies including topics like CMP with nanomaterials and 3D chips Discusses different types of CMP tools pads for IC CMP modeling and the applicability of tribometrology to various aspects of CMP

Covers nanotopography CMP performance and defect profiles CMP waste treatment and the chemistry and colloidal properties of the slurries used in CMP Provides a perspective on the opportunities and challenges of the next fifteen years Complete with case studies this is a valuable hands on resource for professionals including process engineers equipment engineers formulation chemists IC manufacturers and others With systematic organization and questions at the end of each chapter to facilitate learning it is an ideal introduction to CMP and an excellent text for students in advanced graduate courses that cover CMP or related semiconductor manufacturing processes

**Chemical-Mechanical Planarization of Semiconductor Materials** M. R. Oliver, 2014-01-15      **Chemical Mechanical Planarization VI** Sudipta Seal, 2003

**Advances in Chemical Mechanical Planarization (CMP)** Babu Suryadevara, 2021-09-10 Advances in Chemical Mechanical Planarization CMP Second Edition provides the latest information on a mainstream process that is critical for high volume high yield semiconductor manufacturing and even more so as device dimensions continue to shrink The second edition includes the recent advances of CMP and its emerging materials methods and applications including coverage of post CMP cleaning challenges and tribology of CMP This important book offers a systematic review of fundamentals and advances in the area Part one covers CMP of dielectric and metal films with chapters focusing on the use of current and emerging techniques and processes and on CMP of various materials including ultra low k materials and high mobility channel materials and ending with a chapter reviewing the environmental impacts of CMP processes New content addressed includes CMP challenges with tungsten cobalt and ruthenium as interconnect and barrier films consumables for ultralow topography and CMP for memory devices Part two addresses consumables and process control for improved CMP and includes chapters on CMP pads diamond disc pad conditioning the use of FTIR spectroscopy for characterization of surface processes and approaches for defection characterization mitigation and reduction Advances in Chemical Mechanical Planarization CMP Second Edition is an invaluable resource and key reference for materials scientists and engineers in academia and R D Reviews the most relevant techniques and processes for CMP of dielectric and metal films Includes chapters devoted to CMP for current and emerging materials Addresses consumables and process control for improved CMP including post CMP

**Chemical Mechanical Planarization in IC Device Manufacturing III** Robert Leon Opila, 2000 This volume contains the proceedings of the third international symposium on Chemical Mechanical Planarization integrated circuit device manufacturing held at the 196th Meeting of the Electrochemical Society in Honolulu Hawaii October 20 22 1999

*Chemical Mechanical Planarization IV* R. L. Opila, 2001      **Chemical-mechanical Planarization**, 2002      **Tribology In Chemical-Mechanical Planarization** Hong Liang, David Craven, 2005-03-01 Illustrating their intersecting role in manufacturing and technological development this book examines tribological principles and their applications in CMP including integrated circuits basic concepts in surfaces of contacts and common defects as well as friction lubrication fundamentals and the basics of wear The book concludes its focus with mechanical aspects of CMP pad materials elastic

modulus and cell buckling As the first source to integrate CMP and tribology Tribology in Chemical Mechanical Planarization provides applied scientists and engineers in the fields of semiconductors and microelectronics with clear foresight to the future of this technology *Advanced Nanoscale ULSI Interconnects: Fundamentals and Applications* Yosi

Shacham-Diamand, Tetsuya Osaka, Madhav Datta, Takayuki Ohba, 2009-09-19 In Advanced ULSI interconnects fundamentals and applications we bring a comprehensive description of copper based interconnect technology for ultra lar scale integration ULSI technology for integrated circuit IC application In grated circuit technology is the base for all modern electronics systems You can nd electronics systems today everywhere from toys and home appliances to a planes and space shuttles Electronics systems form the hardware that together with software are the bases of the modern information society The rapid growth and vast exploitation of modern electronics system create a strong demand for new and improved electronic circuits as demonstrated by the amazing progress in the eld of ULSI technology This progress is well described by the famous Moore s law which states in its most general form that all the metrics that describe integrated circuit performance e g speed number of devices chip area improve expon tially as a function of time For example the number of components per chip d bles every 18 months and the critical dimension on a chip has shrunk by 50% every 2 years on average in the last 30 years This rapid growth in integrated circuits te nology results in highly complex integrated circuits with an increasing number of interconnects on chips and between the chip and its package The complexity of the interconnect network on chips involves an increasing number of metal lines per interconnect level more interconnect levels and at the same time a reduction in the interconnect line critical dimensions **Nanoparticle Engineering for Chemical-Mechanical Planarization** Ungyu Paik, Jea-Gun Park, 2019-04-15 In the development of next generation

nanoscale devices higher speed and lower power operation is the name of the game Increasing reliance on mobile computers mobile phone and other electronic devices demands a greater degree of speed and power As chemical mechanical planarization CMP progressively becomes perceived less as black art and more as a cutting edge technology it is emerging as the technology for achieving higher performance devices Nanoparticle Engineering for Chemical Mechanical Planarization explains the physicochemical properties of nanoparticles according to each step in the CMP process including dielectric CMP shallow trend isolation CMP metal CMP poly isolation CMP and noble metal CMP The authors provide a detailed guide to nanoparticle engineering of novel CMP slurry for next generation nanoscale devices below the 60nm design rule They present design techniques using polymeric additives to improve CMP performance The final chapter focuses on novel CMP slurry for the application to memory devices beyond 50nm technology Most books published on CMP focus on the polishing process equipment and cleaning Even though some of these books may touch on CMP slurries the methods they cover are confined to conventional slurries and none cover them with the detail required for the development of next generation devices With its coverage of fundamental concepts and novel technologies this book delivers expert insight into CMP for all

current and next generation systems      **Integrated Modeling of Chemical Mechanical Planarization for Sub-Micron IC Fabrication** Jianfeng Luo, David A. Dornfeld, 2013-03-09 Chemical mechanical planarization or chemical mechanical polishing as it is simultaneously referred to has emerged as one of the critical processes in semiconductor manufacturing and in the production of other related products and devices MEMS for example Since its introduction some 15 years ago CMP as it is commonly called has moved steadily into new and challenging areas of semiconductor fabrication Demands on it for consistent efficient and cost effective processing have been steady This has continued in the face of steadily decreasing feature sizes impressive increases in wafer size and a continuing array of new materials used in devices today There are a number of excellent existing references and monographs on CMP in circulation and we defer to them for detailed background information They are cited in the text Our focus here is on the important area of process models which have not kept pace with the tremendous expansion of applications of CMP Preston's equation is a valuable start but represents none of the subtleties of the process Specifically we refer to the development of models with sufficient detail to allow the evaluation and tradeoff of process inputs and parameters to assess impact on quality or quantity of production We call that an integrated model and more specifically we include the important role of the mechanical elements of the process      **Microelectronic Applications of Chemical Mechanical Planarization** Yuzhuo Li, 2007-10-19 An authoritative systematic and comprehensive description of current CMP technology Chemical Mechanical Planarization CMP provides the greatest degree of planarization of any known technique The current standard for integrated circuit IC planarization CMP is playing an increasingly important role in other related applications such as microelectromechanical systems MEMS and computer hard drive manufacturing This reference focuses on the chemical aspects of the technology and includes contributions from the foremost experts on specific applications After a detailed overview of the fundamentals and basic science of CMP Microelectronic Applications of Chemical Mechanical Planarization Provides in depth coverage of a wide range of state of the art technologies and applications Presents information on new designs capabilities and emerging technologies including topics like CMP with nanomaterials and 3D chips Discusses different types of CMP tools pads for IC CMP modeling and the applicability of tribometry to various aspects of CMP Covers nanotopography CMP performance and defect profiles CMP waste treatment and the chemistry and colloidal properties of the slurries used in CMP Provides a perspective on the opportunities and challenges of the next fifteen years Complete with case studies this is a valuable hands on resource for professionals including process engineers equipment engineers formulation chemists IC manufacturers and others With systematic organization and questions at the end of each chapter to facilitate learning it is an ideal introduction to CMP and an excellent text for students in advanced graduate courses that cover CMP or related semiconductor manufacturing processes      **Abrasive Technology** Anna Rudawska, 2018-10-24 The subject matter of this book is the information on the abrasive technology methods the characteristics of the methods for example the technological parameters tools and

machines innovative methods characteristics of surface structure and surface properties after this type of mechanical process and application in various industrial branches and other technical and technological domains Abrasive technology is very important for example in precision component manufacturing and nano technology devices The aim of this book is to present information on the characteristics and applications of abrasive technology abrasive tools tests and also the innovative methods of this technology This information enables scientists engineers and designers to ensure the soundness and integrity of the fabricated components and to develop new techniques effectively

**Proceedings of the Second International Symposium on Chemical Mechanical Planarization [sic] in Integrated Circuit Device Manufacturing** Robert

Leon Opila, L. Zhang, 1998 **Handbook of Semiconductor Manufacturing Technology** Yoshio Nishi, Robert

Doering, 2017-12-19 Retaining the comprehensive and in depth approach that cemented the bestselling first edition's place as a standard reference in the field the Handbook of Semiconductor Manufacturing Technology Second Edition features new and updated material that keeps it at the vanguard of today's most dynamic and rapidly growing field Iconic experts Robert Doering and Yoshio Nishi have again assembled a team of the world's leading specialists in every area of semiconductor manufacturing to provide the most reliable authoritative and industry leading information available Stay Current with the Latest Technologies In addition to updates to nearly every existing chapter this edition features five entirely new contributions on Silicon on insulator SOI materials and devices Supercritical CO<sub>2</sub> in semiconductor cleaning Low dielectrics Atomic layer deposition Damascene copper electroplating Effects of terrestrial radiation on integrated circuits ICs Reflecting rapid progress in many areas several chapters were heavily revised and updated and in some cases rewritten to reflect rapid advances in such areas as interconnect technologies gate dielectrics photomask fabrication IC packaging and 300 mm wafer fabrication While no book can be up to the minute with the advances in the semiconductor field the Handbook of Semiconductor Manufacturing Technology keeps the most important data methods tools and techniques close at hand

**Chemical-Mechanical Polishing of Low Dielectric Constant Polymers and Organosilicate Glasses** Christopher Lyle Borst, William N. Gill, Ronald J. Gutmann, 2013-11-27 As semiconductor manufacturers implement copper conductors in advanced interconnect schemes research and development efforts shift toward the selection of an insulator that can take maximum advantage of the lower power and faster signal propagation allowed by copper interconnects One of the main challenges to integrating a low dielectric constant low kappa insulator as a replacement for silicon dioxide is the behavior of such materials during the chemical mechanical planarization CMP process used in Damascene patterning Low kappa dielectrics tend to be softer and less chemically reactive than silicon dioxide providing significant challenges to successful removal and planarization of such materials The focus of this book is to merge the complex CMP models and mechanisms that have evolved in the past decade with recent experimental results with copper and low kappa CMP to develop a comprehensive mechanism for low and high removal rate processes The result is a more in depth look into the fundamental

reaction kinetics that alter selectively consume and ultimately planarize a multi material structure during Damascene patterning



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