

MICRO & NANO TECHNOLOGIES

Hot Embossing

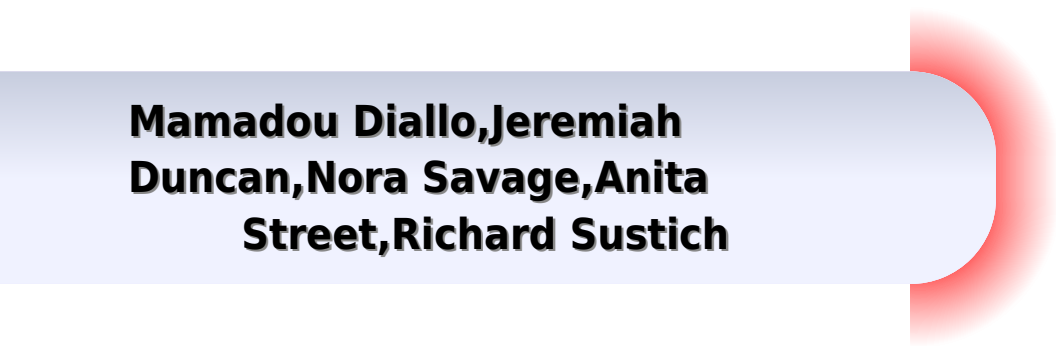
Theory and Technology of Microreplication

Matthias Worgull



Hot Embossing Theory And Technology Of Microreplication Micro And Nano Technologies

**Mamadou Diallo,Jeremiah
Duncan,Nora Savage,Anita
Street,Richard Sustich**



Hot Embossing Theory And Technology Of Microreplication Micro And Nano Technologies:

Hot Embossing Matthias Worgull, 2009-09-28 This book is an overview of replication technology for micro and nanostructures focusing on the techniques and technology of hot embossing a scaleable and multi purpose technology for the manufacture of devices such as BioMEMS and microfluidic devices which are expected to revolutionize a wide range of medical and industrial processes over the coming decade The hot embossing process for replicating microstructures was developed by the Forschungszentrum Karlsruhe Karlsruhe Institute of Technology where the author is head of the Nanoreplication Group Worgull fills a gap in existing information by fully detailing the technology and techniques of hot embossing He also covers nanoimprinting a process related to hot embossing with examples of actual research topics and new applications in nanoreplication A practical and theoretical guide to selecting the materials machinery and processes involved in microreplication using hot embossing techniques Compares different replication processes such as micro injection molding micro thermoforming micro hot embossing and nanoimprinting Details commercially available hot embossing machinery and components like tools and mold inserts

Theory and Technology of Microreplication (Micro and Nano Technologies) Lami'ah Mikhail, 2014-12-18 Nanotechnology nanotech is the manipulation of matter on an atomic molecular and supramolecular scale The earliest widespread description of nanotechnology referred to the particular technological goal of precisely manipulating atoms and molecules for fabrication of macroscale products also now referred to as molecular nanotechnology A more generalized description of nanotechnology was subsequently established by the National Nanotechnology Initiative which defines nanotechnology as the manipulation of matter with at least one dimension sized from 1 to 100 nanometers This definition reflects the fact that quantum mechanical effects are important at this quantum realm scale and so the definition shifted from a particular technological goal to a research category inclusive of all types of research and technologies that deal with the special properties of matter that occur below the given size threshold It is therefore common to see the plural form nanotechnologies as well as nanoscale technologies to refer to the broad range of research and applications whose common trait is size Because of the variety of potential applications including industrial and military governments have invested billions of dollars in nanotechnology research Through its National Nanotechnology Initiative the USA has invested 3 7 billion dollars The European Union has invested when 1 2 billion and Japan 750 million dollars

Hot Embossing Matthias Worgull, 2024-06-03 The second edition of Hot Embossing Theory of Microreplication will present the current state of the art in microreplication with a focus on hot embossing nanoimprint thermoforming and roll to roll replication Polymer processing the theory of polymers and the processing of polymers are discussed in detail Aspects of process simulation and the corresponding material models are also covered The book contains in depth analysis of processing processes and replication techniques including mold fabrication Monitoring data analysis and reliability of molded parts is also discussed In the Second Edition new processes are included including the process of micro

and nanothermoforming to generate 3D structures and the hot pulling processes to generate hierarchical structures with high aspect ratios Based on hot pulling Nanofur for Oil water separation is a large scale biomimetic application Upscaling especially the seamless roll to roll replication is also explored The book is designed to cover the entire workflow for a seamless lithographic sleeve This new edition marks a substantial update of the previous edition incorporating several new chapters It is an important resource for materials scientists and engineers working in the areas of micro and nanofabrication Comprehensively updated to include new techniques processes and variables that have come to prominence in recent years Includes new chapters that address monitoring properties of molded parts 3D thermoforming hot pulling functional materials smart surfaces and upscaling by roll 2 roll Discusses the entire microreplication process from theory and processes to technology and mold to surface oriented applications

Handbook of Silicon Based MEMS Materials and Technologies
Markku Tilli, Mervi Paulasto-Kröckel, Teruaki Motooka, Veikko Lindroos, 2015-09-02 The Handbook of Silicon Based MEMS Materials and Technologies Second Edition is a comprehensive guide to MEMS materials technologies and manufacturing that examines the state of the art with a particular emphasis on silicon as the most important starting material used in MEMS The book explains the fundamentals properties mechanical electrostatic optical etc materials selection preparation manufacturing processing system integration measurement and materials characterization techniques sensors and multi scale modeling methods of MEMS structures silicon crystals and wafers also covering micromachining technologies in MEMS and encapsulation of MEMS components Furthermore it provides vital packaging technologies and process knowledge for silicon direct bonding anodic bonding glass frit bonding and related techniques shows how to protect devices from the environment and provides tactics to decrease package size for a dramatic reduction in costs Provides vital packaging technologies and process knowledge for silicon direct bonding anodic bonding glass frit bonding and related techniques Shows how to protect devices from the environment and decrease package size for a dramatic reduction in packaging costs Discusses properties preparation and growth of silicon crystals and wafers Explains the many properties mechanical electrostatic optical etc manufacturing processing measuring including focused beam techniques and multiscale modeling methods of MEMS structures Geared towards practical applications rather than theory

Nanotechnology Applications for Clean Water Mamadou Diallo, Jeremiah Duncan, Nora Savage, Anita Street, Richard Sustich, 2009-02-12 The World Health Organization in 2004 estimated approximately 1.1 billion people did not have access to clean water and that 35% of Third World residents died from water borne illnesses While the situation is grim recent advances strongly indicate that many of the current water quality problems can be addressed and potentially resolved using nanotechnology Nanotechnology is already having a dramatic impact on research in water quality and Nanotechnology Applications for Clean Water highlights both the challenges and the opportunities for nanotechnology to positively influence this area of environmental protection Here you will find detailed information on breakthroughs cutting edge technologies current research and future trends that

may affect acceptance of widespread applications The first four parts of the book cover specific topics including using nanotechnology for clean drinking water in both large scale water treatment plants and in point of use systems For instance recent advances show that many of the current problems involving water quality can be addressed using nanosorbents nanocatalysts bioactive nanoparticles nanostructured catalytic membranes and nanoparticle enhanced filtration The book also discusses existing technologies and future potential for groundwater remediation pollution prevention and sensors The final part discusses the inherent societal implications that may affect acceptance of widespread applications Over 80 leading experts from around the world share their wealth of knowledge in this truly unique reference Institutions such as Center for the Purification of Water and Systems Univ of Illinois at Urbana Champaign UCLA Water Technology Center Carnegie Mellon University University of Kentucky The University of Western Ontario Pacific Northwest National Laboratory National Institute for Advanced Industrial Science and Technology Japan Munasinghe Institute for Development Sri Lanka and the Woodrow Wilson Center for Scholars are just a few of the knowledge centers represented in this book Water quality is a serious global issue in which government bodies and scientific communities face many challenges in ensuring clean water is available to everyone Nanotechnology is already showing dramatic results and this book is an attempt to share current technologies and future possibilities in reaching this goal From the Foreword Researchers and practitioners may find in this volume key challenges regarding clean water resources The presentations may crystallize new research and education programs Mihail Roco U S National Science Foundation and U S Nanotechnology Initiative Contributors from the US India Canada Japan UK Sri Lanka and South Africa Provides detailed information on breakthroughs cutting edge technologies current research and future trends that may affect acceptance of widespread applications Covers specific topics including using nanotechnology for clean drinking water in both large scale water treatment plants and in point of use systems Discusses existing technologies and future potential for groundwater remediation pollution prevention and sensors Highlights both the challenges and the opportunities for nanotechnology to positively influence this area of environmental protection

Micromixers Nam-Trung Nguyen, 2008-05-07 A wide range of applications in chemistry and biochemistry are driving the rapid development of microfluidics This book focuses its attention on an important subtopic of microfluidics mixing in microscale It provides the fundamentals of transport effects in microscale including molecular diffusion convection and chaotic advection The science and technology of microfluidics cover a wide spectrum and the science of mixing in microscale has evolved from reports on fabricated devices to an extensive collection of established knowledge The focal point of Micromixers Fundamentals Design and Fabrication is the current applicable knowledge and practical issues in designing fabricating and characterizing micromixers in the chemical and biochemical industries Based on scaling law it recommends practical micromixer designs utilizing the advantages of the microscale effects The book is intended for practicing engineers and for upper level undergraduate and graduate level students Provides the basic terminology and fundamental physics of

transport effects used for designing micromixers Highlights the challenges and advantages of miniaturization in mixing Outlines currently available microtechnologies for fabricating micromixers Discusses current applications including lab on a chip for chemical biochemical analysis and chemical production Defines concepts such as electrohydrodynamic dielectrophoretic electrokinetic magneto hydrodynamic acoustic and thermal effects and their implementation in micromixers

Droplet Interactions and Spray Processes Grazia Lamanna, Simona Tonini, Gianpietro Elvio Cossali, Bernhard Weigand, 2020-03-14 This book provides a selection of contributions to the DIPSI workshop 2019 Droplet Impact Phenomena Spray Investigations as well as recent progress of the Int Research Training Group DROPIT The DIPSI workshop which is now at its thirteenth edition represents an important opportunity to share recent knowledge on droplets and sprays in a variety of research fields and industrial applications The research training group DROPIT is focused on droplet interaction technologies where microscopic effects influence strongly macroscopic behavior This requires the inclusion of interface kinetics and or a detailed analysis of surface microstructures Normally complicated technical processes cover the underlying basic mechanisms and therefore progress in the overall process modelling can hardly be gained Therefore DROPIT focuses on the underlying basic processes This is done by investigating different spatial and or temporal scales of the problems and by linking them through a multi scale approach In addition multi physics are required to understand e g problems for droplet wall interactions where porous structures are involved

Labs on Chip Eugenio Iannone, 2018-09-03 Labs on Chip Principles Design and Technology provides a complete reference for the complex field of labs on chip in biotechnology Merging three main areas fluid dynamics monolithic micro and nanotechnology and out of equilibrium biochemistry this text integrates coverage of technology issues with strong theoretical explanations of design techniques Analyzing each subject from basic principles to relevant applications this book Describes the biochemical elements required to work on labs on chip Discusses fabrication microfluidic and electronic and optical detection techniques Addresses planar technologies polymer microfabrication and process scalability to huge volumes Presents a global view of current lab on chip research and development Devotes an entire chapter to labs on chip for genetics Summarizing in one source the different technical competencies required Labs on Chip Principles Design and Technology offers valuable guidance for the lab on chip design decision making process while exploring essential elements of labs on chip useful both to the professional who wants to approach a new field and to the specialist who wants to gain a broader perspective

Handbook of Encapsulation and Controlled Release Munmaya Mishra, 2015-12-01 The field of encapsulation especially microencapsulation is a rapidly growing area of research and product development The Handbook of Encapsulation and Controlled Release covers the entire field presenting the fundamental processes involved and exploring how to use those processes for different applications in industry Written at a level comp

Nanoimprint Lithography: An Enabling Process for Nanofabrication Weimin Zhou, 2013-01-04 Nanoimprint Lithography An enabling process for nanofabrication presents a comprehensive description of

nanotechnology that is one of the most promising low cost high throughput technologies for manufacturing nanostructures and an emerging lithography candidates for 22 16 and 11 nm nodes It provides the exciting multidisciplinary field offering a wide range of topics covering principles process material and application This book would be of specific interest for researchers and graduate students in the field of nanoscience nanotechnology and nanofabrication material physical chemical electric engineering and biology Dr Weimin Zhou is an associate professor at Shanghai Nanotechnology Promotion Center China

Prozessentwicklung eines industrietauglichen Verfahrens zur Fertigung von vereinzelt LIGA-Mikrobauteilen Heneka, Jochen, 2015-04-02 This work deals with the development of an industry suited process aiming on the fabrication based on the LIGA technique of near net shape single microparts Those microparts should lead to new innovative ideas and thus to successful products on the market

Röntgenlinsen mit großer Apertur Markus Simon, 2014-08-14 Von fokussierenden Röntgenoptiken sind bei Photonenenergien oberhalb von etwa 15 keV refraktive Linsen im Vorteil Zur Entwicklung von großaperturigen Linsen für Energien ab 15 keV ist es vorteilhaft das Verhältnis der Anzahl der brechenden Linsenoberflächen zum absorbierenden Linsenvolumen zu erhöhen Diese Arbeit beschreibt die Entwicklung und Herstellung von Röntgenlinsen nach diesem Ansatz mit Aperturen größer 1mm bei Fokalfleckgrößen unter 10 µm und Transparenzen um 40%

Dreidimensional nanostrukturierte und superhydrophobe mikrofluidische Systeme zur Tröpfchengenerierung und -handhabung Laura Zimmermann, 2014-08-20 Neue Mikrofluidiksysteme bieten die Möglichkeit für innovative biomedizinische Anwendungen wie die Verkapselung von einzelnen Zellen eingesetzt zu werden Tröpfchenbasierte Systeme sind in der Lage biologische Prozesse die in kleinen Tröpfchen ablaufen präzise nach Ort und Zeit aufzulösen wobei die Tröpfchen ein konstantes Tröpfchenvolumen aufweisen müssen Ein Ansatz ist mikrofluidische Systeme mit superhydrophoben Kanälen zu fertigen was im Rahmen dieser Arbeit gezeigt wurde

Integration organischer Laser in Lab-on-Chip Systeme Christoph Vannahme, 2014-08-24 In dieser Arbeit wird eine Plattform für einwegtaugliche photonische Systeme auf Polymerbasis vorgestellt in die sowohl organische Halbleiterlaser als auch optofluidische Laser integriert sind Lab on Chip Systeme mit integrierten organischen Halbleiterlasern Wellenleitern und Mikrofluidikkanälen werden realisiert und mit integrierten Lasern Fluoreszenz angeregt Auf den Chips wird eine Funktionalisierung aufgebracht und es werden Wellenleitergitterkoppler aus Phospholipiden untersucht

Rapid Thermal Response Hot Embossing of Micro and Nano Features Thomas E. Kimerling, 2003 **Intelligent Heat Control for a Hot Embossing Micro Replication System** Akash Shrikant Deodhar, 2005 **Modeling and Optimization of the Hot Embossing Process for Micro and Nano Component Fabrication** Jean-Francois Hetu, K. K. Kabanemi, Industrial Materials Institute (Canada), Institut des matériaux industriels (Canada), 2005

Analysis and Control of a Hot Embossing Microfabrication Microreplication System Aditya Shailesh Deshmukh, ProQuest Dissertations and Theses (Electronic resource collection), University of Texas at Arlington. College of Engineering, 2004 [Hot Embossing as a Method for Rapid](#)

Prototyping Microfluidic Devices Khanh Huy Nguyen, Massachusetts Institute of Technology. Department of Mechanical Engineering, 2013 Hot embossing is a growing technology proven to be capable of reproducing micro scale features on thermoplastics and can be an effective process for rapid prototyping microfluidic devices with high aspect ratio micro features Advantages of this manufacturing process can include tooling flexibility fast production time low capital cost and a vast selection of production materials A greater understanding on the micro feature transferring capabilities and use limits of tools are needed so that hot embossing may advance to becoming a practical technique for producing microfluidic parts This work focuses on both the design and analysis of a hot embossing system and a brass tool to replicate an existing functional high aspect ratio micro feature onto Polymethyl methacrylate PMMA The aspect ratio of features ranged from 10:1 to 4000:1 Optimal embossing parameters used a pressure of 3.5 kN hold time of 12 minutes tool temperatures of 140 °C and substrate temperature of 130 °C to produce parts that filled shoulder heights and widths up to 97% and 90% respectively The wearing of features on the metal tool were also characterized for purposes of understanding the limits on tool use and was found that a maximum range of 3 µm in dimensional change existed Gains in tool dimensions were then mainly attributed to the deposition of embossed materials onto the tool The study further determined a method for creating usable resin tool copies that exhibited a replication accuracy of less than 2% on average for micron size features

Development of a Low-cost, Rapid-cycle Hot Embossing System for Microscale Parts Melinda Rae Hale, Massachusetts Institute of Technology. Department of Mechanical Engineering, 2009 Hot embossing is an effective technology for reproducing micro scale features in polymeric materials but large scale adoption of this method is hindered by high capital costs and low cycle times relative to other technologies and a general lack of manufacturing equipment This work details a hot embossing machine design strategy motivated by maximum production speed and quality with minimal capital cost The approach is to right size the machine for specific product needs while making the design flexible and scalable Toward this end a minimal number of components were used commercially available off the shelf components were chosen where possible system layout was designed to be modular and system size was scaled for the intended products in this case microfluidic devices Innovative design aspects include the use of new ceramic substrate heaters for electrical heating use of a moveable heat sink to minimize heat load during the heating cycle and the careful design of the thermal elements to minimize the heating and cooling cycle times The capital cost and the cost per part produced with this machine are estimated to be an order of magnitude less than currently available hot embossing manufacturing options The hot embossing machine has been tested extensively to characterize the process variability The minimum cycle time is two minutes and microstructures are replicated within a maximum of a 25mm by 75mm area with very low relative variance in dimensions

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