

Contents

PREFACE	xvii
ACKNOWLEDGMENTS	xix
PART I: OVERVIEWS OF PHOTON AND ION BEAM PROCESSING	
*AN OVERVIEW OF LASER CHEMICAL PROCESSING R.M. Osgood, Jr.	3
*MICROFABRICATION TECHNOLOGIES FOR ADVANCED VLSI DEVICES Y. Horiike, R. Yoshikawa, H. Okano, M. Nakase, H. Komano, and T. Takigawa	17
*FUNDAMENTALS OF PICOSECOND AND FEMTOSECOND LASER SOLID INTERACTIONS H. Kurz	27
*THE ROLE OF LOW-ENERGY ION/SURFACE INTERACTIONS DURING CRYSTAL GROWTH FROM THE VAPOR PHASE J.E. Greene, A. Rockett, and J.-E. Sundgren	39
PART II: DIRECT WRITING WITH LASERS AND ION BEAMS	
SURFACE TEMPERATURE RISE INDUCED BY A FOCUSED LASER BEAM. APPLICATION TO LASER-INDUCED CHEMICAL VAPOR DEPOSITION T.T. Kodas, T.H. Baum, and P.B. Comita	57
NUCLEATION AND GROWTH OF SILICON MICROSTRUCTURES BY DIRECT-LASER WRITING D.E. Kotecki and I.P. Herman	65
PYROLYTIC LASER DIRECT WRITING OF NICKEL OVER POLYIMIDES S.J. Bezuk, R.J. Baseman, C. Kryzak, K. Warner, and G. Thomas	75
LASER-INDUCED THERMAL DECOMPOSITION OF PLATINUM METALLO- ORGANIC FILMS A. Gupta, R.C. Sausa, and J.R. White	83
PHOTON AND ION BEAM-INDUCED CHEMISTRY OF PALLADIUM ACETATE FILMS M.E. Gross, W.L. Brown, J. Linnros, L.R. Harriott, K.D. Cummings, and H.O. Funsten	91
FINE LINE PATTERNING BY FOCUSED ION BEAM INDUCED DECOMPOSITION OF PALLADIUM ACETATE FILMS L.R. Harriott, K.D. Cummings, M.E. Gross, W.L. Brown, J. Linnros, and H.O. Funsten	99
*Invited Paper	

CHEMICALLY-ENHANCED GaAs MASKLESS ETCHING USING A NOVEL FOCUSED ION BEAM ETCHING SYSTEM WITH A CHLORINE MOLECULAR AND RADICAL BEAM	107
N. Takado, K. Asakawa, H. Arimoto, T. Morita, S. Sugata, E. Miyauchi, and H. Hashimoto	

PART III: LASER AND PHOTOCHEMICAL DEPOSITION OF METALS

*SURFACE PHOTOCHEMICALLY ACTIVATED CHEMICAL VAPOR DEPOSITION OF PATTERNED ALUMINUM THIN FILMS	117
G.S. Higashi, G.E. Blonder, and C.G. Fleming	
DIRECT WRITING OF Al ON Si BY UV EXPOSURE PRIOR TO LASER-ASSISTED CVD	129
J.E. Bouree, J. Flicstein, and Y.I. Nissim	
LASER-INDUCED DEPOSITION OF GOLD	141
T.H. Baum	
UV PHOTON-ASSISTED REFRACTORY METAL DEPOSITION	145
G.A. Kovall, J.C. Matthews, and R. Solanki	
UV MULTIPHOTON DISSOCIATION OF GROUP VIB HEXACARBONYLS AND DERIVATIVES	151
G.W. Tyndall and R.L. Jackson	
MECHANISMS FOR THE DEPOSITION OF THIN METALLIC FILMS BY LASER DRIVEN GAS PHASE REACTIONS	159
T.R. Jervis, S.K. Menon, E.L. Joyce, and D.W. Carroll	
LASER-INDUCED DEPOSITION OF GOLD MICROPATTERNS FROM METALLOPOLYMER THIN FILMS: A PHOTOCHEMICAL APPROACH	165
V.H. Houlding, N.S. Clements, K.W. Beeson, and G.A. West	
UV LASER-INDUCED METAL DEPOSITION ON SEMICONDUCTORS FROM ELECTROPLATING SOLUTIONS	173
J. Zahavi and P.E. Pehrsson	
PHOTON-INDUCED ADHESION AND CHEMICAL CHANGES IN ALUMINUM FILMS ON SILICON	179
A.J. Kellock, J. Liesegang, G.L. Nyberg, and J.S. Williams	

PART IV: ULTRAVIOLET PHOTON-
ASSISTED DEPOSITION OF Si AND Ge

LASER PHOTOCHEMICAL VAPOR DEPOSITION OF Ge FILMS ($300 \leq T < 873$ K) from GeH_4 : ROLES OF Ge_2H_6 AND Ge	189
K.K. King, V. Tavitian, D.B. Geohegan, E.A.P. Cheng, S.A. Piette, F.J. Scheltens, and J.G. Eden	
COMPARISON OF THE PROCESSES INDUCED BY MERCURY LAMP AND ArF EXCIMER LASER PHOTOASSISTED CVD OF a-Si:H FILMS	195
C. Fuchs and E. Fogarassy	

*Invited Paper

MODELLING OF Hg(3P_1) PHOTSENSITIZATION OF SiH ₄ AND SURFACE REACTIONS OF THE SiH ₃ RADICAL J. Perrin and T. Broekhuizen	201
DEPOSITION OF a-Si FILMS USING SILANE MOLECULAR BEAMS EXCITED BY HEATED WIRE AND ArF LASER M. Hanabusa, T. Tsuboi, T. Sato, S. Furuno, S. Iguchi, and T. Inoue	209
PART V: LASER-INDUCED DEPOSITION OF III-V COMPOUND SEMICONDUCTORS	
STEPWISE MONOLAYER GROWTH OF GaAs BY PULSED LASER METAL ORGANIC VAPOR PHASE EPITAXY A. Doi, Y. Aoyagi, and S. Namba	217
CHARACTERIZATION OF EXCIMER LASER DEPOSITED GaAs FILMS FROM THE PHOTOLYSIS OF TRIMETHYLGALLIUM AND TRIMETHYLARSINE AT 193 nm V.R. McCrary, V.M. Donnelly, D. Brasen, A. Appelbaum, and R. Farrow	223
EXCIMER LASER-ASSISTED DEPOSITION OF GaAs, AlAs, AND [Al,Ga]As FROM LEWIS ACID-BASE ADDUCTS J.J. Zinck, P.D. Brewer, J.E. Jensen, G.L. Olson, and L.W. Tutt	233
LASER STIMULATED DEPOSITION OF GaAs, GaAsP AND GaAsP-GaAs SUPERLATTICES N.H. Karam, S.M. Bedair, N.A. El-Masry, and D. Griffis	241
PART VI: PHOTO-INDUCED GROWTH OF INSULATORS	
OPTICALLY-INDUCED, ROOM-TEMPERATURE OXIDATION OF GALLIUM ARSENIDE C-F. Yu, M.T. Schmidt, D.V. Podlesnik, and R.M. Osgood, Jr.	251
PHOTOENHANCED DEPOSITION OF SILICON OXIDE THIN FILMS USING AN INTERNAL NITROGEN DISCHARGE LAMP P.A. Robertson and W.I. Milne	257
PHOTO-CVD OF DIELECTRIC FILMS BY A MICROWAVE-EXCITED VUV LAMP K. Tamagawa, T. Hayashi, and S. Komiya	265
ALTERNATIVE REACTANTS FOR THE LASER-ASSISTED DEPOSITION OF SILICON NITRIDE ON METALS J.P. Partridge and P.R. Strutt	273
REAL-TIME STUDIES OF LASER OXIDATION OF COPPER: CHARACTERISTICS OF AN OPTICAL HEAT SOURCE L. Baufay, F.A. Houle, and R.J. Wilson	281
LASER-INDUCED FORMATION OF THIN TiO ₂ FILMS FROM TiCl ₄ AND OXYGEN ON A SILICON SURFACE T. Kawai, T. Choda, and S. Kawai	289

OXIDATION AND NITRIDATION BY PULSED LASER IRRADIATION OF SOLIDS IMMERSSED IN LIQUIDS S. Roorda, A. Polman, S.B. Ogale, and F.W. Saris	297
RAPID FORMATION OF BERYLLIUM NITRIDE AND BERYLLIUM OXIDE BY EXCIMER LASER IRRADIATION OF SAMPLES IMMERSSED IN LIQUIDS D. Dijkkamp, X.D. Wu, S-W. Chan, and T. Venkatesan	303
SYNTHESIS OF DIAMOND BY LASER-INDUCED CVD K. Kitahama, K. Hirata, H. Nakamatsu, S. Kawai, N. Fujimori, and T. Imai	309
PART VII: ION-ASSISTED THIN FILM FORMATION	
*INVESTIGATIONS OF LOW-TEMPERATURE EPITAXY, ION DAMAGE, AND REACTIVE-ION CLEANING UTILIZING ION BEAM DEPOSITION B.R. Appleton, R.A. Zuhr, T.S. Noggle, N. Herbots, and S.J. Pennycook	319
INFLUENCE OF ION BOMBARDMENT ON THE NUCLEATION AND GROWTH OF PLASMA DEPOSITED AMORPHOUS SILICON A.M. Antoine and B. Drevillon	333
ION BOMBARDMENT EFFECT ON THE GROWTH OF MICROCRYSTALLINE GERMANIUM B. Drevillon, C. Godet, and A.M. Antoine	341
ROOM TEMPERATURE GROWTH OF SILICON DIOXIDE USING A LOW ENERGY ION BEAM S.S. Todorov and E.R. Fossum	349
PART VIII: LASER-INDUCED ETCHING AND ABLATION	
*SURFACE PROCESSES IN LASER-INDUCED ETCHING OF SILICON STUDIED BY X-RAY PHOTOELECTRON SPECTROSCOPY M. Hirose and T. Ogura	357
*PHOTOCHEMICAL DRY ETCHING OF SEMICONDUCTORS AND ITS RELATIONSHIP TO SEMICONDUCTOR ELECTRONIC PROPERTIES C.I.H. Ashby	369
DIRECT-WRITING OF HIGH-ASPECT-RATIO TRENCHES IN SILICON G.V. Treyz, R. Beach, and R.M. Osgood, Jr.	377
FLUORINE ATOM PRODUCTION MECHANISMS FROM COF ₂ AND NF ₃ IN UV LASER ETCHING OF POLY-SILICON AND MOLYBDENUM G.L. Loper and M.D. Tabat	385
ETCHING OF SiO ₂ WITH CO ₂ AND CO ₂ + Ar ⁺ LASERS D. Pan, B.T. Dai, B.S. Agrawalla, K. Imen, and S.D. Allen	395

*Invited Paper

ULTRAFAST AQUEOUS ETCHING OF GALLIUM ARSENIDE A.E. Willner, D.V. Podlesnik, H. Gilgen, and R.M. Osgood, Jr.	403
LASER-ASSISTED SELECTIVE CHEMICAL ETCHING OF GaAs/AlGaAs LAYERED STRUCTURES R.T. Brown, J.F. Black, R.N. Sacks, G.G. Peterson, and F.J. Leonberger	411
ETCHING OF LiNbO_3 BY LASER-DRIVEN FUSION OF SALTS C.I.H. Ashby and P.J. Brannon	419
A MECHANISTIC STUDY OF THE INTERACTION OF ULTRAVIOLET LASER RADIATION WITH LOW DENSITY POLYMERS P.J. Hargis, Jr.	425
EXCIMER LASER APPLICATIONS: POLYMER ETCHING AND METAL DEPOSITION M. Ritz, V. Srinivasan, S.V. Babu, and R.C. Patel	433
PART IX: MECHANISMS OF Si AND SiO_2 ETCHING	
*THE INFLUENCE OF DOPING ON THE ETCHING OF Si(111) H.F. Winters and D. Haarer	443
CONSTANT FINAL-STATE PHOTOEMISSION STUDY OF SILICON FLUORIDE REACTION LAYER CREATED DURING ETCHING: MORPHOLOGY OF THE REACTION LAYER J.A. Yarnoff and F.R. McFeely	451
CATALYZED GASEOUS ETCHING OF SILICON N. Selamoglu, J.A. Mucha, D.L. Flamm, and D.E. Ibbotson	459
REACTIONS OF BARE SILICON CLUSTER IONS: PROTOTYPICAL DEPOSITION AND ETCHING VERSUS CLUSTER SIZE M.L. Mandich, W.D. Reents, Jr., and V.E. Bondybey	467
REACTIONS OF FLUORINE-CONTAINING COMPOUNDS ON THERMAL SiO_2 S. Joyce and J.I. Steinfeld	477
THE KINETIC ENERGY AND ANGULAR DISTRIBUTION OF SPUTTERED POLYATOMIC MOLECULES: OUTLINE AND APPLICATIONS R.A. Haring	483
PART X: ION-ASSISTED CHEMICAL ETCHING	
Cl_2 REACTIVE ION BEAM ETCHING OF HEAVY n-TYPE Si E.E. Krueger and A.L. Ruoff	493
A NEW METHOD FOR ANALYZING THIN SIDEWALL INHIBITOR LAYERS J.P. McVittie, T.A. Lin, and A.J. Bariya	499

*Invited Paper

CHEMICALLY ASSISTED ION BEAM ETCHING OF TUNGSTEN USING ClF_3 C. Garner	509
SURFACE FLUORINATION OF POLYIMIDE THIN FILMS BY $\text{CF}_4 + \text{O}_2$ REACTIVE ION BEAM ETCHING W.E. Vanderlinde and A.L. Ruoff	517
THE EFFECT OF HYDROGEN ION BOMBARDMENT ON FLUOROCARBON POLYMERS T.L. Cheeks and A.L. Ruoff	527
PART XI: PHOTON, ION AND ELECTRON EFFECTS ON SURFACE CHEMISTRY	
*CONTROL OF THE SURFACE REACTIVITY OF THE $\text{Si}(100)$ SURFACE J.T. Yates, Jr., M.J. Bozack, L. Muehlhoff, and W.J. Choyke	539
LASER AND THERMAL INDUCED REACTIONS OF $\text{Mo}(\text{CO})_6$, $\text{CH}_3\text{CH}_2\text{OH}$, AND NO ON $\text{Si}(111) 7 \times 7$ Z. Ying and W. Ho	551
DEPOSITION OF IRON ON $\text{Si}(111)-(7 \times 7)$: PHOTO-AND ELECTRON-ASSISTED DECOMPOSITION OF $\text{Fe}(\text{CO})_5$ J.R. Swanson, C.M. Friend, and Y.J. Chabal	559
PRODUCTION OF ELECTRONICALLY EXCITED P_2 AND In FROM ArF EXCIMER LASER IRRADIATION OF InP V.M. Donnelly, V.R. McCrary, and D. Brasen	567
COMPARISON OF LOW INTENSITY LASER ENHANCEMENT OF OXYGEN CHEMISORPTION ON GaAs USING O_2 AND N_2O K.A. Bertness, C.E. McCants, T.T. Chiang, P.H. Mahowald, A.K. Wahi, T. Kendelewicz, I. Lindau, and W.E. Spicer	575
MECHANISM OF IR AND UV LASER-INDUCED EVAPORATION AND ABLATION FROM CONDENSED MOLECULAR SYSTEMS P. Hess	583
THE ROLE OF SINGLE AND MULTI-ELECTRON EXCITATIONS IN ELECTRON STIMULATED DESORPTION Ph. Avouris, F. Bozso, and A.R. Rossi	591
EXCITED-ATOM PRODUCTION BY ELECTRON BOMBARDMENT OF ALKALI-HALIDES R.E. Walkup, Ph. Avouris, and A.P. Ghosh	599
SURFACE CHEMICAL REACTIONS STIMULATED BY LOW ENERGY ELECTRON BOMBARDMENT R.R. Kunz and T.M. Mayer	609

*Invited Paper

PART XII: APPLICATIONS OF
SELECTIVE-AREA PHOTOCHEMISTRY

*UV LASER PROCESSING OF SEMICONDUCTOR DEVICES T.W. Sigmon	619
*LASER MICROFABRICATION TECHNOLOGY AND ITS APPLICATION TO HIGH SPEED INTERCONNECT OF GATE ARRAYS A.F. Bernhardt, B.M. McWilliams, F. Mitlitsky, and J.C. Whitehead	633
LASER-CHEMICAL DEPOSITION AND ETCHING ON THE METALLIZA- TION LEVEL OF INTEGRATED CIRCUITS A.W. Johnson and K.E. Greenberg	645
GaAs CIRCUIT RESTRUCTURING BY MULTI-LEVEL LASER-DIRECT- WRITTEN TUNGSTEN PROCESS J.G. Black, S.P. Doran, M. Rothschild, J.H.C. Sedlacek, and D.J. Ehrlich	651
HOLOGRAPHIC PHOTOETCHING OF HIGH-QUALITY DIFFRACTION GRATINGS IN p-GaAs FOR DISTRIBUTED FEEDBACK LASERS R. Matz	657
CRYSTALLOGRAPHIC EFFECTS ON THE PHOTOELECTROCHEMICAL ETCHING OF GRATINGS IN COMPOUND SEMICONDUCTORS M.M. Carrabba, N.M. Nguyen, and R.D. Rauh	665
PHOTOPATTERNING OF METAL OXIDE CATALYST IN POROUS GLASS J.C. Luong, N.F. Borrelli, J.W.H. Schreurs, and D.L. Morse	671

PART XIII: OTHER METHODS OF THIN FILM
FORMATION AND CHARACTERIZATION

IN-SITU RAPID ISOTHERMAL PROCESSING OF THIN EPITAXIAL DIELECTRIC FILMS ON SILICON AND COMPOUND SEMICONDUCTORS R. Singh, F. Radpour, J. Narayan, S.P. Joshi, M. Rahmati, S. Anandakugan, and S.K. Kahng	681
DEPOSITION OF LOW-STRESS ENCAPSULANTS ON InP AND GaAs U.K. Chakrabarti, S.J. Pearton, H. Barz, A.R. Vonneida, K.T. Short, and J.W. Lee	691
NONLINEAR OPTICAL STUDY OF Si EPITAXY T.F. Heinz, M.M.T. Loy, and S.S. Iyer	697
CROSS-SECTIONAL TEM INVESTIGATION OF LOW-TEMPERATURE EPITAXIAL SILICON FILMS GROWN BY ULTRA-LOW PRESSURE CVD T.R. Yew, J.H. Comfort, L.M. Garverick, W.R. Burger, and R. Reif	705
QUANTIFICATION OF HYDROGEN AND DETERMINATION OF THE BINDING STATE IN a-Si:H:D BY THERMAL DESORPTION SPECTROSCOPY N. Yabumoto, Y. Muramatsu, and M. Oshima	713

*Invited Paper

CHEMICAL VAPOR DEPOSITION OF GOLD C.E. Larson, T.H. Baum, and R.L. Jackson	721
A HIGH RESOLUTION TEM STUDY OF IN-SITU SURFACE OXIDATION OF INDIUM III-V SEMICONDUCTORS D.J. Smith and A.K. Petford-Long	725
PHOTOINDUCED TOPOTAXIAL EXCHANGE REACTIONS IN CADMIUM SULPHIDE THIN FILMS T.J. Cumberbatch, P.E. Barden, and J. Knightley	731
CHARACTERIZATION OF SURFACES AND THIN FILMS BY MEANS OF AN ION MICROPROBE ANALYZER E. Izumi, Y. Ikebe, H. Shichi, and H. Tamura	739
PART XIV: NOVEL PLASMA PROCESSES	
PLASMA STIMULATED GROWTH OF InP FROM TEI AND PH ₃ H. Heinecke, F. Grafahrend, A. Brauers, H. Luth, and P. Balk	747
A MODEL FOR SILICON DENDRITE GROWTH DURING LASER/PLASMA DEPOSITION FROM A SILANE DISCHARGE H.M. Anderson and P.J. Hargis, Jr.	755
PROPERTIES OF DIAMONDLIKE CARBON FILMS K. Fujii, S.H. Yokota, and N. Shōhata	765
PLASMA DEPOSITION OF TUNGSTEN K.E. Greenberg	773
AN INVESTIGATION INTO THE GROWTH OF LEAD TITANATE BY MOCVD USING A PYROLYTIC AND A SPUTTER ASSISTED PLASMA PROCESS C.J. Brierley, L. Considine, R.S. Sethi, and R.W. Whatmore	779
OXYGEN EXCHANGE PHENOMENA IN SiO ₂ DURING MICROWAVE- DISCHARGE PLASMA OXIDATION S-I. Kimura, E. Murakami, T. Warabisako, E. Mitani, and H. Sunami	787
INDUCTIVELY-COUPLED PLASMA NITRIDING OF FUSED SILICA T.K. Vethanayagam and P.F. Johnson	793
CORONA-DISCHARGE-INDUCED STRESS RELAXATION IN SILICON DIOXIDE FILMS ON SILICON L.M. Landsberger and W.A. Tiller	803
METALLIC SURFACE MODIFICATION VIA THERMAL PLASMA TECHNIQUES F.W. Giacobbe	809
AUTHOR INDEX	819
SUBJECT INDEX	823