

Ultrafast Phenomena in Semiconductors

**Proceedings of the 10th International Symposium on
Ultrafast Phenomena in Semiconductors (10-UFPS),
held in Vilnius, Lithuania, August/September 1998**

Editors:

Steponas Ašmontas and Adolfas Dargys

Semiconductor Physics Institute
Vilnius, Lithuania

 **TRANS TECH PUBLICATIONS LTD**
Switzerland • Germany • UK • USA

Table of Contents

Committees and Sponsors	v
Invited Speakers	vi
Preface	vii
Acknowledgements	viii

I. Quantum Transport and Tunneling

Quantum Transport and Minimum Switching Voltage in a Field-Effect Transistor	
M. Willander, Y. Fu and O. Nilsson	3
New Features of Spatial-Temporal Dynamics of Bloch Oscillations	
M. Dignam, K. Köhler, K. Leo, K. Litvinenko, F. Löser, V.G. Lyssenko, M. Sūdžius and G. Valušis	11
Nonharmonic Bloch Oscillations in GaAs/AlGaAs Superlattices	
K. Litvinenko, K. Köhler, K. Leo, F. Löser and V. G. Lyssenko	17
Wigner Paths for Quantum Transport in Semiconductors	
P. Bordone, R. Brunetti, M. Pascoli, A. Bertoni and C. Jacoboni	21
DX Center Breakdown in High Electric Fields	
A. Dargys, N. Žurauskienė, E. Goovaerts, C. Van Hoof and G. Borghs	25
High-Speed Switching of Double-Barrier Resonant-Tunneling Light-Emitting Diodes Investigated by Picosecond Electroluminescence Measurements	
I. Romandić, N. Žurauskienė, E. Goovaerts, C. Van Hoof and G. Borghs	29
Electrooptical Phenomena in Tunnel-Coupled Quantum Wells in Longitudinal Electric Field	
L.E. Vorobjev, V.L. Zerova, I.E. Titkov, D.A. Firsov, V.A. Shalygin, V.N. Tulupenko and E. Towe	33
Optical Phenomena under Hole Heating and Real Space Transfer in p-Type InGaAs/GaAs MQW Heterostructures	
V.Ya. Aleshkin, A.A. Andronov, A.V. Antonov, D.M. Gaponova, V.I. Gavrilenko, D.G. Revin, B.N. Zvonkov, I.G. Malkina and E.A. Uskova	37
Multiminiband Transport in Superlattices: Effects, Description and Prospect for the Terahertz Bloch Oscillator – a Laser without Inversion	
A.A. Andronov and I.M. Nefedov	41
Hot Electron FIR Emission and Absorption in GaAs/AlGaAs QW	
L.E. Vorobjev, S.N. Danilov, D.V. Donetsky, V.L. Zerova, Yu.V. Kochegarov, D.A. Firsov, V.A. Shalygin, G.G. Zegrya and E. Towe	45

Spectral Functions for Ultra-Fast Phenomena and High Field Transport in Semiconductors	
L. Rota and L. Reggiani	49
Mobility Edge in Nondegenerate Semiconductor with Random Potential of Charged Impurities	
M.S. Kagan, E.G. Landsberg and N.G. Zhdanova	53
 II. High-Speed Electronics and Photonics	
Optical Probing of Ultrafast Devices	
H.G. Roskos, T. Pfeifer, H.-M. Heiliger, T. Löffler and H. Kurz	59
Ultrafast Spectroscopy of Semiconductor Devices	
P. Borri, W.W. Langbein and J.M. Hvam	67
Coherent Exciton and Biexciton Nonlinearities in Semiconductor Nanostructures: Effects of Disorder	
W. Langbein, P. Borri and J.M. Hvam	73
Coherent and Incoherent Aspects of the Coupled Exciton-Phonon System	
V.M. Axt, K. Siantidis, M. Herbst, T. Kuhn, S. Grosse, M. Koch and J. Feldmann	79
High Speed Optoelectronic Devices for Optical to Millimetre Wave Conversion	
J.-P. Vilcot, V. Magnin, J. Harari, M. Fendler and D. Decoster	87
Picosecond Switching Due to Electron Tunneling and Avalanche in a GaAs/Al_{0.34}Ga_{0.66}As Diode	
A. Geižutis, A. Krotkus, A. Reklaitis and M. Asche	95
Dense Electron-Hole Plasma Effects on Energy Relaxation in Highly Excited Polar Semiconductors	
S. Juršėnas, G. Kurilčik and A. Žukauskas	99
Carrier-Carrier Interaction and Fast Intersubband Scattering in Wide GaAs Quantum Wells	
L. Rota, M. Hartig, S. Haacke, P.E. Selbmann and B. Deveaud	103
Ultrafast Optical Processes in Novel Phosphate Glasses Doped with CdSe Quantum Dots	
K.V. Yumashev, A.M. Malyarevich, N.N. Posnov, I.A. Denisov, V.P. Mikhailov and A.A. Lipovskii	107
Nondestructive Characterisation of MOVPE-Grown CdTe and ZnTe Epilayers by Picosecond and Nanosecond “Excite-Probe” Techniques	
E. Gaubas, V. Mizeikis, L. Bastienė, K. Jarašiūnas, N. Lovergine, A.M. Mancini, P. Prete and L. Subačius	111

Influence of Growth Defects on Carrier Lifetime and Transport in Semiinsulating GaAs Studied by Transient Light-Induced Grating Technique	
V. Mizeikis, K. Jarašiūnas, V. Gudelis and M. Sūdžius	115
Z-Scan Measurements of Transient and Stationary Optical Nonlinearities in Semiconductor-Metal Nanocomposites	
R. Adomavičius and A. Krotkus	119
Measurement of Low Repetition Rate Picosecond Laser Pulse Parameters	
A. Ozols, J. Porins, A. Kristins and G. Ivanovs	123
III. Chaos and Noise	
Monte Carlo Simulation of Shot-Noise Suppression in Multiple Tunneling Transport	
L. Reggiani and A. Reklaitis	129
Shot-Noise Suppression in Nondegenerate Conductors	
T. González	139
Hydrodynamic Modeling of Spatial Cross-Correlation of Conduction Current Fluctuations	
P. Shiktorov, J.C. Vaissiere, L. Varani, J.P. Nougier, E. Starikov, V. Gružinskis, T. González, J. Mateos, D. Pardo and L. Reggiani	147
A Novel Hydrodynamic Modeling of Noise Spectra under Constant Voltage Operation	
L. Varani, P. Shiktorov, J.C. Vaissiere, J.P. Nougier, E. Starikov, V. Gružinskis and L. Reggiani	151
Dependence of Electron Energy Relaxation on Lattice Strain in InGaAs 2DEG Channels	
A. Matulionis, V. Aninkevičius, J. Liberis, I. Matulionienė and J. Berntgen	155
Hydrodynamic Modeling of Transport and Noise Phenomena in Bipolar Two-Terminal Silicon Structures	
G. Ferrante, M. Zarccone, E. Starikov, P. Shiktorov, V. Gružinskis, L. Varani and L. Reggiani	159
CAD-Oriented, Physics-Based Large- and Small-Signal Noise Analysis of Bipolar Semiconductor Devices	
F. Bonani, S. Donati Guerrieri, G. Ghione and M. Pirola	163
Hyperchaos in the Arrays of Mean-Field Coupled Oscillators	
A. Čenys, A. Tamaševičius and A.N. Anagnostopoulos	167

Small Signal Amplification Caused by Non-Linear Properties of Compensated Germanium	
S. Bumeliene	171
Hot-Electron Noise in a GaAs Planar-Doped Barrier Diode: Experiment and Monte Carlo Simulation	
J. Liberis, V. Gružinskis, A. Matulionis, P. Sakalas, R. Šaltis, E. Starikov, P. Shiktorov and B. Szentpáli	175
 IV. Low Dimensional Structures	
Electron Mobility and Subband Population in Quantum Wells	
J. Požela, K. Požela, A. Namajūnas and V. Jucienė	181
Spontaneous Interlevel Emission From Quantum Dot and Quantum Well Laser Structures	
L.E. Vorobjev, D.A. Firsov, V.A. Shalygin, V.N. Tulupenko, Yu.M. Shernyakov, A.Yu. Egorov, A.E. Zhukov, A.R. Kovsh, P.S. Kop'ev, I.V. Kochnev, N.N. Ledentsov, M.V. Maximov, V.M. Ustinov and Zh.I. Alferov	189
Recombination Dynamics of Unthermalised Excitons in Quantum Well Structures of II-VI Semiconductors	
M. Godlewski	197
Spin Polarized Transport in 1D and 2D Semiconductor Heterostructures	
A. Bournel, P. Dollfus, P. Bruno and P. Hesto	205
Klein-Gordon Equation for Quantum Heat Transport in Semiconductor	
M. Kozłowski and J. Marciak-Kozłowska	213
Metastable Thermal States in Semiconductor Double Barrier Structures	
M. Kozłowski, J. Marciak-Kozłowska and Z. Mucha	217
Population Inversion and Intraband IR Lasing under Hot Electron Intervalley Transfer in GaAs-AlAs Like MQW Heterostructures	
V.Ya. Aleshkin, A.A. Andronov and E.V. Demidov	221
Magnetoplasma Excitations in Vertically Coupled Quantum Dot Systems	
B. Partoens, A. Matulis and F.M. Peeters	225
Dynamics of Microwave Induced Changes of Photoluminescence of 2D Carriers in Modulation Doped Structures of GaAs/AlGaAs	
M. Godlewski, A. Khachepuridze and V.Yu. Ivanov	229

Shallow Acceptor States in SiGe Quantum Wells	
M.S. Kagan, I.V. Altukhov, K.A. Korolev, D.V. Orlov, V.P. Sinis, S.G. Thomas, K.L. Wang, K. Schmalz and I.N. Yassievich	233
Experimental Evidence of the Two-Dimensional Electron Gas in CdS Quantum Wells of CdS/ZnSe Heterostructures	
V. Kažukauskas, M. Grün, St. Petillon, A. Storzum and C. Klingshirn	237
Photomodulation Processes in GaAs/AlAs Type-I Quantum Well Structures	
J. Kavaliauskas, G. Krivaitė, B. Čechavičius, V.I. Kadushkin, E.V. Klyshevich, E.L. Shangina and F.M. Tsahhaev	241
Exciton-Phonon Interaction in Quantum Well Structures of CdTe/CdMnTe and CdMnTe/CdMgTe	
R. Narkowicz and M. Godlewski	245
Zeeman Splitting and Non-Reciprocal Effects of Coupled Photon- Exciton Modes in CdTe/CdMnTe Multiple Quantum Wells in the Voigt Geometry	
R. Narkowicz, R. Brazis and L. Safonova	249
Influence of Electric Field on Photoluminescence Quenching in GaAs/AlGaAs Quantum Wells	
S. Ašmontas, A. Čėsna, J. Gradauskas, K. Köhler, A. Kundrotaitė, J. Kundrotas, A. Sužiedėlis and G. Valušis	253
Electron Transport and Heating in Semiconductors with One- Dimensional Superlattice	
Yu.Yu. Romanova, E.V. Demidov and Yu.A. Romanov	257
Far Infrared Emission and Population Inversion of Hot Holes in MQW InGaAs/GaAs Heterostructures under Real Space Transfer	
V.Ya. Aleshkin, A.A. Andronov, A.V. Antonov, N.A. Bekin, A.V. Gavrilenko, V.I. Gavrilenko, D.G. Revin, E.A. Uskova, B.N. Zvonkov, N. B. Zvonkov, W. Knap, J. Lusakowski and C. Skierbiszewski	261
Lattice Strain and Band Offsets Determination in ZnSe/ZnS Short- Period Superlattices Grown by MOVPE on (100)GaAs	
P. Prete, N. Lovergine, R. Cingolani and A.M. Mancini	265
 V. Classical Transport and Hot Electrons	
Physical Mechanisms for TeraHertz Generation	
E. Starikov, P. Shiktorov and V. Gružinskis	271
Investigations of the High Field Electron Transport Characteristics in Bulk GaAs and InP	
M. Suhecka	279

Electric Current Study under Parallel and Perpendicular Directions of Uniaxial Pressure and Strong Electric Field in p-Ge	
A.A. Abramov, V.I. Akimov, A.T. Dalakyan, V.N. Tulupenko, A.M. Zaitcev, S.N. Danilov, D.A. Firsov and V.A. Shalygin	283
Absorptive Fourier Transient Grating Spectroscopy in Indirect Semiconductors and Quantum Structures	
V. Grivickas	287
Carrier Capture to Deep Levels in Semi-Insulating InP and GaInP	
S. Marcinkevičius, A. Čėsna, D. Söderström and S. Lourdudoss	291
Fast Photoresponse in Inhomogeneous Semiconductors under Infrared Laser Excitation	
S. Ašmontas, J. Gradauskas, D. Seliuta, E. Širmulis, A. Michailovas and E. Babrauskas	295
Two-Temperature Hot Electron-Hole Plasma in Strongly Photoexcited Semiconductors	
E. Shatkovskis	299
Electrical Transport Effects in the Epitaxial $\text{La}_{0.67}\text{Ca}_{0.33}\text{MnO}_3$ Films and $\text{La}_{0.67}\text{Ca}_{0.33}\text{MnO}_3/(\text{LaNiO}_3, \text{RuO}_2)$ Heterostructures	
B. Vengalis, A.K. Oginskis, V. Lisauskas, N. Shiktorov, V. Jasutis, S.A. Karpinkas, A. Česnys and A. Maneikis	303
Light Emission Due to Hot-Electron Direct Transitions in Silicon	
T. Puritis	307
Generation of Donor Centers in p-InSb by Laser Radiation	
A. Medvid' and L. Fedorenko	311
Enhancement of the Third Harmonic Generation Efficiency in n-Type Si and InP by Cooling from Room Temperature to 80K	
Ph. Moreau, M.R. Siegrist, R. Brazis and R. Raguoitis	315
Influence of Composition in GaAs/AlGaAs Heterojunctions on Microwave Detection	
S. Ašmontas, J. Gradauskas, J. Kundrotas, A. Sužiedėlis, A. Šilėnas and G. Valušis	319
Nature of Ultrafast Recombination in a-Si:H	
G. Juška and K. Arlauskas	323
Charge Carrier Transport in $\mu\text{c-Si:H}$	
G. Juška, K. Arlauskas, K. Genevičius and J. Kočka	327

VI. Microdevices

Study of the Non Linear I-U Characteristic of the Heterostructure α -Si/c-Si

K.G. Kyritsi, A.N. Anagnostopoulos, G.L. Bleris, V.A. Samuilov and A. Čenys 333

THz Frequency Power Generation Possibility Due to Nonparabolicity in $n^+ - n - n^+$ 4H-SiC Structures

V. Gružinskis, J.H. Zhao, P. Shiktorov and E. Starikov 337

Gunn Effect and THz Frequency Power Generation in $n^+ - n - n^+$ GaN Structures

V. Gružinskis, J.H. Zhao, P. Shiktorov and E. Starikov 341

Vertical Transport and Current Instabilities in i-GaAs - i-AlAs - n-GaAs Heterostructure Hot Electron Diode at Auger Ionization

A.M. Belyantsev, Ju.Yu. Romanova and A.L. Korotkov 345

Direct Effective Transformation of a Videopulse into a Radiopulse at the Electromagnetic Shock Wave (EMSW) Synchronism with Forward and Backward Spatial Harmonics of Periodic Microstrip Transmission Line Based on Multilayer Heterostructure (MLHS)

A.M. Belyantsev and A.B. Kozyrev 349

Cyclotron Resonance Quantum Hall Effect Detector

A.V. Antonov, I.V. Erofeeva, V.I. Gavrilenko, N.G. Kalugin, A.L. Korotkov, A.V. Maslovskii, M.D. Moldavskaya, S.I. Pripolzin, V.L. Vaks, Y. Kawano and S. Komiyama 353

High-Power Subnanosecond Voltage Transient Generation Using Superconducting Optoelectronic Switch

S. Balevičius, A. Jukna, E. Šhatkovskis, O. Kiprijanovič, V. Pyragas, B. Vengalis, V. Lisauskas, F. Anisimovas, R. Butkutė, A. Abrutis and L. Altgilbers 357

Optical Phonon Line in Boron-Doped Silicon BIB Structures

L. Asadauskas, R. Brazis and J. Leotin 361

Closing Remarks

J. Požela 365

Author Index

369

Keyword Index

373