

Cleanroom Vienna

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This report is a summary of the 1999 main activities of the MISZ TU Wien (micro-structure center). The available technologies for the production of optoelectronic and microelectronic prototype devices are: state of the art growth of III-V nanostructures, standard contact lithography, the production of patterned masks to be used in standard lithography, various structuring techniques like dry etching and plasma enhanced chemical vapor deposition, electron beam writing, focused ion beam etching and depositing, and various metallization techniques. An additional molecular beam system was brought into the cleanroom end 1999 and will be set up within the ongoing year. State of the art silicon processing began in 1998 and may need further support to mature. In 1999 the installation of various oxidation and diffusion furnaces to be used in silicon processes started. In this report, a short description of research projects with a high need of technological input, using the equipment in the cleanroom and the cleanroom environment, is given.

1. Introduction

The present main research areas of the solid state electronics institute taking advantage of the fully equipped cleanroom of the MISZ are: transport studies in low dimensional semiconductor nanostructures, scanning probe spectroscopy, realization of new and improved optoelectronic devices, quantum cascade lasers, THz sources, and the characterization of microelectronic devices.

To satisfy this variety of topics, state of the art growth of semiconductor nanostructures is needed as well as a complete process line including structure definition (lithography), structure transfer (RIE, FIB, ion milling, wet chemical etching techniques) and coating with metals and/or dielectrics (PE-CVD, sputtering, electron gun evaporation, FIB deposition). All the equipment necessary for the above mentioned technologies needs the cleanroom environment (cooling, filtered air, constant temperature and humidity, high quality water, various inert gases) as well as periodic maintenance of the equipment and the cleanroom itself, e.g. pumping systems (rotary pumps, turbo pumps), exhaust filtering, liquid nitrogen, and cleaning and repair. Testing of the cleanroom quality and adjustment (laminar air flow, filters, cooling, humidity, temperature) is done periodically.

In 1999, the following additional equipment was installed :

- an wet bench for chemical processes;
- a furnace for wet and dry oxidation and annealing;
- a chemical vapor deposition system for amorphous silicon, silicon nitride, and aluminum oxide coatings;
- a solid source molecular beam epitaxy system.

In the following, the main research activities making use of the cleanroom itself or using samples grown, structured, and tested in the MISZ are described. These activities are not the only projects running in the MISZ, but are intended to show a representative overview of the basic research as well as applied projects which need the cleanroom infrastructure. For a more general overview the listed projects and the attached publication list may give more insides on the broad range of activities.

Project Information

Project Manager

Dr. Gottfried STRASSER

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Project Group

Last Name	First Name	Status	Employer
Bertagnolli	Emmerich	Full Prof.	TU Wien
Boxleitner	Winfried	Post Doc	EC (HQ Sonate)
Bratschitsch	Rudolf	dissertation	FWF (Start)
Finger	Norman	dissertation	TU/VW
Fischler	Wolfgang	dissertation	FWF/Nationalbank
Fuchshuber	Michael	student	
Fürböck	Christoph	dissertation	Infineon
Gianordoli	Stefan	dissertation	EC (Unisel)
Goebel	Bernd	dissertation	Infineon/fke
Gornik	Erich	Full Prof.	TU Wien
Harasek	Stefan	dissertation	GMe
Heer	Rudolf	dissertation	TU Wien
Hirner	Heimo	student	
Hobler	Gerhard	Assistant Prof.	TU Wien
Hoffmann	Rainer	student	
Hvozdar	Lubos	dissertation	EC (Unisel)
Kast	Michael	student	fke
Kellermann	Peer Oliver	dissertation	VW
Kersting	Roland	Post Doc	EC (Interact)
Kostner	Hannes	student	
Kröll	Peter	technician	TU Wien
Langfischer	Helmut	dissertation	GMe
Lampacher	Peter	student	
Langmann	Gottfried	technician	TU Wien
Litzenberger	Martin	dissertation	Infineon/fke
Lugstein	Alois	assistant	TU Wien
Maier	Thomas	dissertation	TU Wien/fke

Last Name	First Name	Status	Employer
Pacher	Christoph	student	GMe
Patz	Sybille	student	
Ploner	Guido	dissertation	FWF (Wittgenstein)
Pogany	Dionyz	guest scientist	Infineon/fke
Prinzinger	Johannes	technician	TU Wien
Rainer	Alexander	secretary	GMe
Rakoczy	Doris	dissertation	FWF
Rauch	Christoph	dissertation	TU Wien
Riegler	Erich	technician	TU Wien
Schinnerl	Markus	technician	TU Wien
Schenold	Helmut	technician	TU Wien
Schrenk	Werner	dissertation	EC (Unisel)
Smoliner	Jürgen	Assistant Prof.	TU Wien
Stöckl	Herbert	technician	TU Wien
Strasser	Gottfried	Assistant Prof.	TU Wien
Thaller	Edwin	student	
Ulrich	Jochen	dissertation	FWF (Wittgenstein)
Unterrainer	Karl	Assistant Prof.	TU Wien
Wanzenböck	Heinz	assistant	TU Wien
Zobl	Reinhard	dissertation	FWF (Start)

Publications in Reviewed Journals

1. R. Heer, J. Smoliner, G. Strasser, E. Gornik: “*Temperature dependent studies of InAs base layers for Ballistic Electron Emission Microscopy*”; Phys. Rev. B **59**, 4618 (1999)
2. J. Smoliner, R. Heer, G. Strasser: “*Biased GaAs-AlGaAs superlattices employed as energy filter for Ballistic Electron Emission Microscopy*”; Surface and Interface Analysis **27**, 542 (1999)
3. R.Heer, J.Smoliner, G.Strasser E.Gornik: “*A highly transmittive semiconductor base for Ballistic Electron Emission Microscopy*”; Surface and Interface Analysis **27**, 517 (1999)
4. C. Rauch, G. Strasser, E. Gornik: “*Current Spectroscopy of Superlattice Bandstructure and Transport*”; Microelectronic Engineering **47**, 59 (1999)
5. J. Smoliner, R. Heer, G. Strasser: “*Ballistic Electron Emission Microscopy on buried GaAs-AlGaAs superlattices*”; Microelectronic Engineering **47**, 69 (1999)
6. O. Gauthier-Lafaye, F.H. Julien, S. Cabaret, J.-M. Lourtioz, G. Strasser, E. Gornik, M. Helm, P. Bois: “*High-power GaAs/AlGaAs Quantum Fountain Laser emitting at 14.5 μm with 2.5% tunability*”; Appl. Phys. Lett. **74**, 1537 (1999)

7. K. Kempa, P. Bakshi, C. Du, G. Feng, A. Scorupsky, G. Strasser, C. Rauch, K. Unterrainer, E. Gornik: “*Towards stimulated generation of coherent plasmons in nanostructures*”; Journ. of Appl. Phys. **85**, 3708 (1999)
8. M. Helm, W. Hilber, G. Strasser, R. De Meester, F.M. Peeters, A. Wacker: “*Continuum Wannier-Stark ladders strongly interacting by Zener resonances in semiconductor superlattices*”; Phys. Rev. Lett. **82**, 3120 (1999)
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10. A. Wacker, S. Bose, C. Rauch, G. Strasser, E. Gornik: “*Transmission through Superlattices with Interface Roughness*”; Superlattices and Microstructures **25**, 43 (1999)
11. C. Rauch, G. Strasser, M. Kast, E. Gornik: “*Mean Free Path of Ballistic Electrons in GaAs/AlGaAs superlattices*”; Superlattices and Microstructures **25**, 45 (1999)
12. J. Ulrich, R. Zobl, K. Unterrainer, G. Strasser, E. Gornik, K.D. Maranowski, A.C. Gossard: “*Temperature dependence of far-infrared electroluminescence in parabolic quantum wells*”; Appl. Phys. Lett. **74**, 3158 (1999)
13. N.E. Hecker, R.A. Höpfel, N. Sawaki, T. Maier, G. Strasser: “*Surface plasmon enhanced photoluminescence from a single quantum well*”; Appl. Phys. Lett. **75**, 1577 (1999)
14. N. Finger and E. Gornik: “*Analysis of Metallized-Grating Coupled Twin-Waveguide Structures*”, IEEE J. Quantum Electron. **35**, No. 5, May 1999
15. P.O. Kellermann, N. Finger, W. Schrenk, E. Gornik, R. Winterhoff, H. Schweizer and F. Scholz: “*Wavelength adjustable surface-emitting single-mode laser diodes with contradirectional surface-mode coupling*”; Appl. Phys. Lett. **75**, 3748 (1999)
16. G. Strasser, L. Hvozda, S. Gianordoli, K. Unterrainer, E. Gornik, P. Kruck, M. Helm: “*GaAs/AlGaAs Quantum Cascade Intersubband and Interminiband Emitter*”; Journal of Crystal Growth **201/202**, 919-922 (1999)
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18. R. Bratschitsch, R. Kersting, G. Strasser, K. Unterrainer, W. Fischler, and R.A. Höpfel: “*THz emission of coherent plasmons in semiconductor superlattices*”, CLEO/QELS '99 Technical Digest, p 221, Baltimore, 23.-28. Mai 1999
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20. J. Smoliner, R. Heer, G. Strasser: “ *$k_{\parallel}=0$ filtering in resonant tunneling processes between materials of different effective electron mass*”; Phys. Rev. B **60**, 5137 (1999)
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23. L. Hvozdar, S. Gianordoli, W. Schrenk, G. Strasser, K. Unterrainer, E. Gornik: “*GaAs/AlGaAs Intersubband MIR Lasers*”; in THz Spectroscopy and Applications II, J.M. Chamberlain, Editor, Proc. of SPIE **3828**, 32 (1999)
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25. G. Strasser, L. Hvozdar, S. Gianordoli, W. Schrenk, K. Unterrainer, E. Gornik, M. Helm: “*Intersubband and interminiband GaAs/AlGaAs quantum cascade lasers at 10 micrometers*”; accepted for publication in Physica E
26. K. Unterrainer, R. Kersting, R. Bratschitsch, G. Strasser, and J. N. Heyman: “*Few-Cycle THz Spectroscopy of Nanostructures*”; accepted in Physica E
27. J. Smoliner, R. Heer, G. Strasser: “*Wave Vector Filtering and Incoherent Transport through Low Dimensional States and Areas of Different Effective Mass*”; accepted for publication in Physica E
28. G. Ploner, H. Hirner, T. Maier, G. Strasser, J. Smoliner and E. Gornik: “*A novel device layout for tunneling spectroscopy of low-dimensional electron systems*”, accepted for publication in Physica E
29. L. Hvozdar, S. Gianordoli, G. Strasser, W. Schrenk, K. Unterrainer, E. Gornik: “*GaAs/AlGaAs unipolar mid-infrared quantum cascade lasers*”, Proc. 26th International Symposium on Compound Semiconductors, Berlin, Germany 22-26 August 1999
30. S. Gianordoli, L. Hvozdar, G. Strasser, W. Schrenk, K. Unterrainer, E. Gornik: “*GaAs/AlGaAs Interminiband Unipolar Semiconductor Laser at 13 μm* ”; Proc. 29th European Solid-State Device Research Conference ESSDERC 99; Leuven, Belgium, 13-15.9.1999
31. G. Strasser, G. Ploner, C. Rauch and E. Gornik: “*Transport Spectroscopy of Quantum Wires and Superlattices*”; Proc. of MBE-GPT, Warsaw, Poland, 1999, accepted for publication in Thin solid Films
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41. R. Heer, D. Rakoczy, G. Ploner, G. Strasser, E. Gornik and J. Smoliner: “*A metal-insulator-metal injector for ballistic electron spectroscopy*”, Appl. Phys. Lett. **75**, 4007-4009 (1999)
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43. C. Fürböck, R. Thalhammer, M. Litzenberger, N. Seliger, D. Pogany, E. Gornik and G. Wachutka: “*A differential backside laser probing technique for the investigation of the lateral temperature distribution in power devices*”, Proc. 11th International Symposium on Power Semiconductor Devices and ICs, Toronto, 193-196 (1999).
44. C. Fürböck, M. Litzenberger, D. Pogany, E. Gornik, T. Müller-Lynch, H. Goßner, M. Stecher and W. Werner: “*Study of bipolar transistor action during ESD stress in Smart Power ESD protection devices using interferometric temperature mapping*”, Proc. of the 29th European Solid-State Device Research Conference, Editions Frontieres, ISBN 2-86332-245-1, 596-599 (1999).
45. C. Fürböck, D. Pogany, M. Litzenberger, E. Gornik, N. Seliger, H. Goßner, T. Müller-Lynch, M. Stecher, and W. Werner: “*Interferometric temperature mapping during ESD stress and failure analysis of Smart Power technology ESD protection devices*”, Proc. EOS/ESD Symposium, Orlando, 241-250 (1999)
46. C. Fürböck, M. Litzenberger, D. Pogany, E. Gornik, N. Seliger, T. Müller-Lynch, M. Stecher, H. Goßner and W. Werner: “*Laser interferometric method for ns-time scale thermal mapping of Smart Power ESD protection devices during ESD stress*”, Microel. Reliab. **39**, 925-930 (1999).

47. R. Zobl, K. Unterrainer, G. Strasser, E. Gornik: “*Magneto-optical terahertz emission from plasmons in parabolic quantum wells*”, accepted for publication in *Semiconductor Science and Technology*
48. G. Ploner and E. Gornik: “*Tunneling spectroscopy of voltage tunable quantum wires*”, Proc. SIMD’99 (Hawaii 1999), accepted for publication in *Superlattices and Microstructures*
49. S. Gianordoli, L. Hvozdar, G. Strasser, W. Schrenk, K. Unterrainer, and E. Gornik: “*GaAs/AlGaAs based micro lasers emitting at 10 μm and 13 μm* ”, IEEE Lasers and Electro-Optics Society, Conf. Proc. LEOS ‘99, ISBN 0-7803-5634-9, 9 (1999)
50. T. Maier, G. Strasser, E. Gornik, M. Moser, R. Hoewel: “*Integrated vertical-cavity laser diodes and resonant photodetectors with hybrid $\text{Si}_3\text{N}_4/\text{SiO}_2$ top Bragg mirrors*”, IEEE Lasers and Electro-Optics Society, Conf. Proc. LEOS ‘99, ISBN 0-7803-5634-9, 677 (1999)
51. C. Rauch, G. Strasser, K. Unterrainer, A. Wacker, E. Gornik: “*Scattering and Bloch oscillation in semiconductor superlattices*”; *Physica B* **272**, 175-179 (1999)
52. M. Helm, W. Hilber, G. Strasser, R. DeMeester, F.M. Peeters, A. Wacker: “*Simultaneous investigation of vertical transport and intersubband absorption in a superlattice: continuum Wannier-Stark ladders and next-nearest neighbor tunneling*”; *Physica B* **272**, 194-197 (1999)
53. M. Helm, W. Hilber, G. Strasser, R. DeMeester, F. M Peeters: “*Minibands and Wannier-Strak Ladders in Semiconductor Superlattices studied by infrared spectroscopy*”; *Braz. J. Physics* **29**, 652-660 (1999)
54. D. Pogany, G. Guillot: “*Random telegraph signal noise instabilities in lattice-mismatched InGaAs/InP photodiodes*”, *Microel. Reliab* **39**, 341-345 (1999)
55. S. Pierunek, D. Pogany, J.L. Autran, B. Leroy: “*Study of hot carrier degradation in dram cells combining random telegraph signal and charge pumping measurements*”, *J. Noncryst. Solids* **245**, 59-66 (1999)
56. D. Pogany, N. Seliger, M. Litzenberger, H. Gossner, M. Stecher, T. Müller-lynch, W. Werner, E. Gornik: “*Damage analysis in smart-power technology electrostatic discharge (ESD) protection devices*”, *Microel. Reliab.* **39**, 1143-1148 (1999)
57. D. Pogany, J. A Chroboczek, G. Ghibaudo: “*Investigation of RTS noise mechanisms in reverse base current of stressed submicron bipolar transistors*”, Proc. Int. Conf. On Noise in Phys. Systems and 1/f Fluctuations, Hong Kong, 22-27 August 1999, pp.348-351.
58. D. Pogany, E. Gornik, M. Stecher, W. Werner: “*Study of random telegraph noise in smart power technology DMOS devices*”, Proc. Int. Conf. On Noise in Phys. Systems and 1/f Fluctuations, Hong Kong, 22-27 August 1999, pp. 88-91.
59. D. Pogany, C. Fürböck, M. Litzenberger, E. Gornik, H. Gossner, K. Esmark, J. Otto, G. Sölkner: “*Stress evolution of low frequency (RTS) noise and leakage current in grounded-gate nMOSFET ESD protection devices*”, Proc. ESSDERC’99, Leuven, Belgium 11-13. Sept. 1999, pp. 604-607.
60. C. Fürböck, K. Esmark, M. Litzenberger, G. Groos, D. Pogany, H. Goßner, M. Stecher, R. Zelsacher, and E. Gornik: “*Backside interferometric thermal mapping of*

ESD protection devices during high current stress”, IEEE Electron Dev. Lett. (submitted).

Non-refereed reports:

1. J. Ulrich, R. Zobl, K. Unterrainer, G. Strasser, E. Gornik, K.D. Maranowski, A.C. Gossard: “*Far-Infrared Electroluminescence in Parabolic Quantum Wells*”; Current developments of microelectronics, ISBN 3-901578-04-8 (1999).
2. C. Fürböck, R. Thalhammer, M. Litzenberger, N. Seliger, G. Wachutka and E. Gornik: “*Internal Characterization of IGBTs Using the Backside Laserprobing Technique*”, Current developments of microelectronics; ISBN 3-901578-04-8, 39 (1999).
3. R. Heer, J. Smoliner, G. Strasser, E. Gornik: “*Enhanced Energy Resolution in Ballistic Electron Emission Microscopy through InAs Base Layers*”; Current developments of microelectronics, ISBN 3-901578-04-8, 181 (1999)
4. C. Rauch, G. Strasser, E. Gornik: “*Onset of Scattering Induced Miniband Transport*”; Current developments of microelectronics, ISBN 3-901578-04-8, 185 (1999)

Presentations

1. R. Kersting, K. Unterrainer, G. Strasser (invited talk): “*Plasma oscillations: emission and modulation of THz pulses*”, PHOTONICS West (Terahertz Spectroscopy and Applications), 27-29 January 1999, San Jose, California.
2. J.N. Heyman, K. Unterrainer, R. Kersting, G. Strasser: “*THz time-domain spectroscopy of wide quantum wells*”, PHOTONICS West (Terahertz Spectroscopy and Applications), 27-29 January 1999, San Jose, California.
3. K. Unterrainer, R. Kersting, J.N. Heyman, G. Strasser, E. Gornik, K.M. Maranowski, A.C. Gossard (invited talk): “*Coherent THz emission from plasmons in semiconductors*”, PHOTONICS West (Ultrafast Phenomena in Semiconductors III), 27-29 January 1999, San Jose, California.
4. Karl Unterrainer (invited talk): “*Few-Cycle THz Spectroscopy of Semiconductor Quantum Structures*”, 1999 Centennial Meeting of the APS, March 20-26, 1999, Atlanta, Georgia.
5. E. Gornik (invited talk): “*THz emission from low dimensional electron systems*”, 1999 Centennial Meeting of the APS, March 20-26, 1999, Atlanta, Georgia.
6. C. Rauch: “*Coherent and Incoherent Electron Transport in Superlattices*”, 1999 Centennial Meeting of the APS, March 20-26, 1999, Atlanta, Georgia.
7. N. Finger, P.O. Kellermann, W. Schrenk and E. Gornik: “*Analysis of surface mode-coupled semiconductor laser structures with adjustable emission wavelength*”, PHOTONICS West (Physics and Simulation of Optoelectronic Devices VII), 27-29 January 1999, San Jose, California.
8. C. Fürböck, R. Thalhammer, M. Litzenberger, N. Seliger, D. Pogany, E. Gornik and G. Wachutka: “*A differential backside laserprobing technique for the investigation*

- of the lateral temperature distribution in power devices*”, ISPSD’99, 25-28 May 1999, Toronto, Canada.
9. C. Fürböck, M. Litzenberger, D. Pogany, E. Gornik, T. Müller-Lynch, H. Goßner, M. Stecher and W. Werner: “*Study of bipolar transistor action during ESD stress in Smart Power ESD protection devices using interferometric temperature mapping*”, ESSDERC’99 – 29th European Solid-State Device Research Conference, 13-15 September 1999, Leuven, Belgium.
 10. C. Fürböck, D. Pogany, M. Litzenberger, E. Gornik, N. Seliger, H. Goßner, T. Müller-Lynch, M. Stecher, and W. Werner: “*Interferometric temperature mapping during ESD stress and failure analysis of Smart Power technology ESD protection devices*”, EOS/ESD Symposium, 27-30 September 1999, Orlando, Florida.
 11. C. Fürböck, M. Litzenberger, D. Pogany, E. Gornik, N. Seliger, T. Müller-Lynch, M. Stecher, H. Goßner and W. Werner: “*Laser interferometric methode for ns-time scale thermal mapping of Smart Power ESD protection devices during ESD stress*”, ESREF’99 – Xth European Symposium Reliability of Electron Devices, Failure Physics and Analysis, 5-8 October 1999, Bordeaux, France.
 12. R. Bratschitsch, R. Kersting, J.N. Heyman, G. Strasser, and K. Unterrainer: “*Visible Pump and THz spectroscopy of semiconductor nanostructures*”, SPIE meeting “Conference on Terahertz Spectroscopy and Applications” , München, 16.-18. Juni 1999.
 13. R. Kersting, R. Bratschitsch, J.N. Heyman, G. Strasser, and K. Unterrainer: “*Few-cycle THz spectroscopy of semiconductor nanostructures*”, SPIE meeting “Conference on Terahertz Spectroscopy and Applications” , München, 16.-18. Juni 1999.
 14. R. Bratschitsch, R. Kersting, G. Strasser, K. Unterrainer, W. Fischler, and R.A. Höpfel: “*THz emission of coherent plasmons in semiconductor superlattices*”, Conference on Lasers and Electro-Optics/Quantum Electronics and Laser Science Conference, CLEO/QELS ’99, Baltimore, 23.-28. Mai 1999.
 15. R. Kersting, R. Bratschitsch, E. Thaller, G. Strasser, K. Unterrainer, and J.N. Heyman: “*Excitation of intersubband transitions by THz pulses*”, Conference on Lasers and Electro-Optics/Quantum Electronics and Laser Science Conference, CLEO/QELS ’99, Baltimore, 23.-28. Mai 1999.
 16. R. Bratschitsch, R. Kersting, E. Thaller, J.N. Heyman, G. Strasser, and K. Unterrainer: “*Few-cycle THz spectroscopy of semiconductor quantum structures*”, DPG Frühjahrstagung, Münster, 22.-26. März 1999.
 17. F.H. Julien, O. Gauthier-Lafaye, G. Strasser (invited): “*Long-wavelength high-power quantum fountain unipolar lasers in GaAs/AlGaAs quantum wells*”; SPIE meeting “Conference on Terahertz Spectroscopy and Applications” , München, June 16-18, 1999
 18. K. Unterrainer, R. Kersting, R. Bratschitsch, G. Strasser, and J. N. Heyman (invited): “*Few-Cycle THz Spectroscopy of Nanostructures*”; 9th International Conference on Modulated Semiconductor Structures (MSS9), Fukuoka, Japan, July 12-16, 1999

19. C. Rauch, G. Strasser, K. Unterrainer, A. Wacker, E. Gornik (invited): “*Scattering and Bloch oscillation in semiconductor superlattices*”; 11th International Conference on Nonequilibrium Carrier Dynamics in Semiconductors (HCIS-11); Kyoto, Japan, July 19-23, 1999
20. T. Maier, G. Strasser and E. Gornik: “*Vertical-cavity surface emitting laser diodes and their integration with resonant-cavity enhanced photodetectors*”, Mauterndorfer Laserseminar, March 22-25, 1999, Mauterndorf, Austria
21. L. Hvozdar, S. Gianordoli, G. Strasser, K. Unterrainer, E. Gornik: “*AlGaAs/GaAs quantum cascade intersubband emitters and lasers*”; SPIE meeting “Conference on Terahertz Spectroscopy and Applications”, München, 16.-18. Juni 1999.
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Doctor's Theses

1. Christina Messner: “*Generierung von gepulster, durchstimmbarer THz-Strahlung zur zeitaufgelösten THz-Spektroskopie an Halbleitern*”.

Diploma Theses

1. Michael Fuchshuber: “*Elektrisch gepumpte Intersubband THz-Emitter*”.
2. Rainer Hoffmann: “*Ultrakurze THz-Pulse von Halbleiter-Heterostrukturen*”.
3. Michael Kast: “*Charakterisierung von Halbleiter-Heterostrukturen*”.
4. Peter Lampacher: “*DRAM-Leseverstärker mit Mismatchkompensation der Entscheidertransistoren*”.
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6. Ban Bishnu: “*Ultrasensitive laser measurement system using an all-electronic noise canceller*”.
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8. Edwin Thaller: “*Intersubband Spectroscopy of Semiconductor Quantum Wells*”.
9. Martin Litzenberger: “*Thermal Characterization of Smart Power Electrostatic Discharge Protection Devices by Backside Laserprobing*”.

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