ANNUAL REPORT

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Department of Microelectronics
Faculty of Electrical Engineering
Czech Technical University in Prague
Czech Republic

CONTENTS:

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Edited by Pavel Kulha (February 2009)

FOREWORD

The Department of Microelectronics belongs to The Faculty of Electrical Engineering (FEE) that is one of the six faculties forming the Czech Technical University in Prague (CTU in Prague). The roots of CTU in Prague can be followed as far back as the year 1705, when Christian Josef Willenberg (1655 - 1731) wrote a letter to Emperor Leopold I. in Vienna seeking permission to begin public teaching of engineering sciences. This was granted by a decree of Emperor Josef I (successor to Leopold I.) on 18 January 1707. For these reasons, the priority of CTU to be the first technical school at university level in the world is usually claimed for.

The Department of Microelectronics has been established in January 1977. During the past 28 years more than 1000 students graduated in the branch of Microelectronics and nearly 50 Ph.D and 5 DrSc. degrees have been awarded. Five persons from the Department staff became professors and 14 Associate Professors. The Department offers the B.Sc., M.Sc. and Ph.D. degrees in Electronics.

The Department maintains international co-operation with many universities, research laboratories, and institutes in the Europe. This is in connection with the LEONARDO and SOCRATES Programmes, EUROPRACTICE projects, the NATO Science for Peace programme, and the Framework Programmes of the European Community.

The Department gives a high priority to collaborative research with industry. The donation from Cadence is being used to continue the education of IC design at industrial level. Several domestic electronic factories were supported by R&D works from the Department this year.

This brochure is the 17th annual review of our Department. The content of this report emphasises our effort for continuing the close association of teaching, research and co-operation with external subjects at both national and international levels.

Prague
February 2009

Pavel Kulha
Editor

STAFF OF THE DEPARTMENT

Head of the Department:	M. Husák, M.Sc., Ph.D.
Deputy:	J. Foit, M.Sc., Ph.D.
Professors:	M. Husák, M.Sc., Ph.D. J. Kodeš, M.Sc., Ph.D., DrSc. (Emeritus Professor) J. Vobecký, M.Sc., Ph.D., DrSc.
Associate Professors:	Z. Burian, M.Sc., Ph.D. J. Foit, M.Sc., Ph.D. P. Hazdra, MSc., Ph.D. M. Šemberová, M.Sc., Ph.D. V. Třeštíková, M.Sc., Ph.D. F. Vaníček, M.Sc., Ph.D. J. Voves, M.Sc., Ph.D.
Assistant Professors:	J. Jakovenko, M.Sc., Ph.D. V. Janíček, M.Sc. V. Jeřábek, M.Sc., PhD. L. Jirásek, M.Sc., Ph.D. P. Kulha, M.Sc. V. Komarnickij, M.Sc. (PhD 2007) A. Krejčiřík, M.Sc., Ph.D. J. Novák, M.Sc. PhD V. Prajzler, M.Sc. (PhD 2007) V. Záhlava, M.Sc., Ph.D.
Ph.D. students:	A. Bouřa, M.Sc. (Part-time res. fellow) J. A. Arciniega, M.Sc. J. Baloun, M.Sc. K. Frýd M.Sc. J. Kroutil, M.Sc. A. Laposa, M.Sc. R.Taragel, M.Sc. T. Teplý, M.Sc. T. Třebický, M.Sc. T. Vítek, M.Sc. (Part-time res. fellow) P. Vrchota M.Sc.

SUPPORT STAFF

Department Secretary	H. Kubátová
Administration	R. Burianová
Teaching Laboratories:	L. Kafka
Technical Service:	M. Horník

ABOUT THE STAFF

Miroslav Husák was born in Kladno in 1953. He graduated in Radioengineering from FEE-CTU in Prague in 1978. Ph.D. in 1985, Assoc. Professor in 1997, Full Professor in 2000. Manager of Microsystems Group. Author or co-author 6 lecture notes and more than 200 scientific and technical papers. Research in the field of microsytems and integrated sensor systems. Teaching the courses Sensor systems, Power Suppliers in Electronics, Electronic Security Systems and Microsystems. Supervisor of Electronics branch (Master and Ph.D. study).

Jiří Kodeš was born in 1932. He received MSc., Ph.D., and D.Sc. degrees in electronics, semiconductor physics and microelectronics from the CTU in Prague in 1956, 1963 and 1990, resp. At present, he is Full Professor at the Department. His area of research includes electronic transport in semiconductors and quantum electronics devices. He is the author or co-author of numerous technical papers in journals and conference proceedings. He has written several textbooks for students.

Jan Vobecký - born 1957, Prague. MSc. (1981) and Ph.D. (1988) from FEE-CTU, Assoc. Professor 1992, DrSc. 1999, Full Professor 2000. Visiting fellow: University of Uppsala (1988, 1989-90), MOTOROLA Toulouse (1993). Author and reviewer of numerous scientific papers, 2 patents, 1 textbook, 9 printed lectures. Education: Electronics, TCAD, Modern Power Devices. Research: Power devices & ICs, Si technology. Scientific Board: FEE-CTU in Prague, Academy of Sciences. Senior Member IEEE. Vice Chairmen CS Section IEEE.

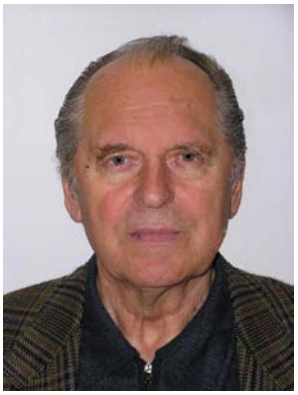
Zdeněk Burian was born in 1944. He graduated from the FEE-CTU in 1966. In 1975 he received PhD. degree. He is the author of 35 technical papers, 10 printed lectures and he owns 7 technical inventions. He is Assoc. Professor and gives lectures on optoelectronics. He is working in the field of integrated optics and planar optical waveguides. He researched the optical waveguides in silica in University of York, U.K.. Member of EOS and Czech Society of Photonics.

Julius Foit was born in 1932. He received MSc., PhD. and Ass. Prof. degrees in Radar Engineering, Colour TV Eng. and Multiphase Signal Processing from the CTU in Prague in 1954, 1961 and 1978, resp.. Dean of the Faculty in the University of Maiduguri, Nigeria in 1987-1989 and B. Tech. Programme Coordinator in the University of Zimbabwe, Harare, in 1990-1993. Currently, he is Associate Professor in the Dept. He is the author of many papers, several monographs and textbooks for students. He is a Fellow of ZIE and Past-President of Rotary Int.

Pavel Hazdra was born in 1960. M.Sc. and Ph.D. in Microelectronics from FEE-CTU. In 1987 and 1996 he became Assistant and Assoc. Professor, resp. In 1988, 1992, and 1993 visiting fellow at the University of Surrey, Hull, and Lund, resp. Research on defects in semiconductors, quantum structures and their characterization. Manager of the Electron Device Group, since 2006 vice-dean of the FEE. More than 160 scientific and technical papers, 2 patents and printed lectures. SM IEEE and chairman of the IEEE MTT/AP/ED Chapter in the Czech Republic.

Miroslava Šemberová was born in 1939. She graduated in Radioelectronics from the FEE-CTU in Prague, in 1961. She received PhD. degree in 1973 and Associate Professorship in 1985. She is author of 12 technical papers and 10 printed lectures. She was giving lectures in the area of electronic and microelectronic components. She was involved in research program concerning MOS integrated circuits and, at present, she is interested in sensors.

Vladimíra Třeštíková was born in 1943. She graduated in Automation technique from the FEE CTU in Prague, in 1965. She received PhD. degree in 1980 and became Associate Professor in 1985. She is presently teaching Electronic and Microelectronic Devices. She is the author of 5 printed lectures and 12 technical papers. She was involved in research program concerning MOS integrated circuit technology and, at present, she is interested in sensors.



František Vaníček was born in 1936. He graduated in Radioelectronics from the FEE-CTU in Prague, in 1960. PhD. in 1972 and Assoc. Professorship in 1978. From 1972 to 1975 he gave lectures in MTC Kahira, Egypt, and from 1981 to 1983 in HIE Beni Walid, Lybia. He is the author of 15 techn. papers and 10 printed lectures. He is teaching in the area of semiconductor structures and their models. The winter term of 1992 and 1993 he spent in KIHWV Ostende in the frame of TEMPUS programme.

Jan Voves was born in Prague in 1960. MSc. and RNDr. degree in Physical Electronics and Optics from the Charles' University in Prague in 1984. Since 1984, Research Assistant in the Department (characterisation of ion implanted doping profiles in semiconductors). From 1987 and 1996, Assistant and Assoc. Professor, resp. Ph.D in 1993. Research in the device physical modelling (Monte Carlo Method). Author of about 30 technical papers and 3 printed lectures. Member of the IEEE.

Jiří Jakovenko born 1972, Prague. He graduated in Microelectronics from FEE-CTU, Ph.D. from FEE-CTU in 2004. Member of Microsystems group. Research: MEMS design and modeling. In 1998 he spent 4 months in Hogeschool Gent in the frame of TEMPUS programme. Author of many scientific and technical papers. Since 1999 Assistant Professor at the Dept. Education: Microelectronics, IC Design, Design of VLSI, Practice of IC design, Electronics.

Vladimír Janíček was born in 1974 in Most. He graduated in Microelectronics from the FEE-CTU in Prague and he belongs to the Microsystems group. His Ph.D. research is in the field of polymer electronics power supply. At present, he is IT manager of the Department

Vítězslav Jeřábek born 1951. 1975: MSc. from FEE-CTU in Prague. 1987: PhD. in Optoelectronics. 1976–91: TESLA Research Institute, Prague. 1981: Optoelectronics Division, dynamics and modelling of optoelectronics devices & broad band optoelectronic modules. 1991–98: Head R&D lab. Dattel Ltd. - integr. optoelectronics modules and systems. Since 1999: teaching technology of optics and optoelectronics components and systems for transmission and processing of information. Author of 35 technical papers, 2 printed lectures and 3 patents, Member IEEE, Committee member of IEE in the Czech Republic.

Lubor Jirásek was born in Prague in 1953. He graduated from the FEE CTU in Prague, in 1978. He received PhD. degree in Electronics in 1983. From 1978 to 1983 he was working as a Research Fellow in the area of high-power devices. He is author of 7 technical papers and 3 printed lectures. He is teaching in the area of semiconductor devices and solid-state physics. Presently, he is responsible for the curriculum of the Department.

Alexandr Krejčiřík was born in 1947. He graduated in Electrotechnology from the Faculty of Electrical Engineering, CTU in Prague, in 1971. He received PhD. degree in Mathematics and Physics – branch Semiconductors. He is the author of 10 technical papers, 21 printed lectures and 12 textbooks. He is teaching courses on Electronics, Power supplies in Electronics and Design of Power Supplies.

Pavel Kulha was born in Písek in 1978. He graduated in Microelectronic from the FEE-CTU in 2002. He is working towards hid PhD in the Microsystem group. He is working as assistant professor since September 2004. His work is concentrated on microsensors and microsystems for high temperature applications.

Jan Novák was born in Prague in 1973. He graduated in Microelectronics from FEE-CTU, Ph.D. from FEE-CTU in 2006. Member of Microsystems group. Research: Electromagnetic compatibility of integrated circuits and microsystems. Since 2001 he is an Assistant Professor at the Department. He is teaching Electronics, PCB Design and IC Design. He is finance manager of the Department.

Václav Prajzler Václav Prajzler was born in Prague, the Czech Republic in April 10th 1976. In 2001 he graduated from the Faculty of Electrical Engineering at the Czech Technical University in Prague at Department of Microelectronics. Since 2005 he has been working at the Czech Technical University in Prague, Faculty of Electrical Engineering, Department of Microelectronics as a research fellow. His current research is focused on the fabrication and the investigation of the properties of optical materials doped with rare earth ions with special focus on GaN and polymeric materials.

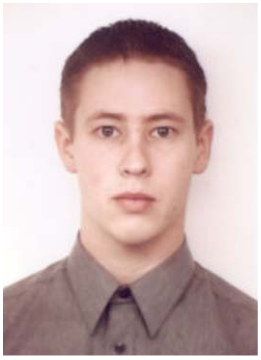
Vít Záhlava was born in Prague in 1965. He graduated in Microelectronics from the FEE-CTU in 1988. Ph.D. degree in 1994. He is teaching Electronics and PCB design. Active in EMC on PCB, design, application and testing. He is a member of the Academic Senate of the Faculty. He is the author of 4 textbooks, several printed lectures for students, and technical papers on power devices.

Adam Bouřa Adam Bouřa was born in Ostrava in 1980. He graduated in Microelectronics from the FEE-CTU in Prague in 2004. Since 2004 he is a PhD student at the Department of Microelectronic and member of the Microsystems group. His work is concentrated on wireless sensor systems. Since January 2005 to February 2006 he was part-time research fellow and since February 2006 he is an assistant professor at the Department. He is teaching Electronics, Electronic Devices and Structures, Sensors for Electronic and Sensors for Medicine.

Julio Armas was born in Ecuador in 1973. In 2000, he graduated in Electronics and telecomunications from the ESCUELA POLITECNICA NACIONAL in Quito, Ecuador. He is currently working as a PhD student in the Optoelectronics group. His work is concentrated on the fabrication and simulation of Microwave Optoelectronics Transmitters and Receivers.

Jiří Baloun was born in Humpolec in 1982. He graduated in Microelectronics from the CTU-FEE in Prague in 2007. Since 2007 he is a PhD student at the Department of Microelectronic. He is a member of the Microsystems group.

Roman Jackiv was born in Ukraine in 1980. In 2002, he graduated from Chernivtcy National University, Ukraine, in specialization “Alternative Power Energy”. The theme of his magister work was “High Temperature Annealing of CdTe Crystals Doped by Chlorine.” He is working towards his Ph.D. in Electron Device Group. His work is Experimental and Theoretical Study of Resonant Tunneling Diodes.



Dmytro Kolesnikov was born in Rjazan, Russia, in 1979. In 2002, he graduated in Physical Electronics from Chernivtsy National University, Ukraine. His master thesis was "Electrical Properties of the Bulk Monocrystalline $CuInSe_2$". He is currently working as a PhD student in the Electron Device Group. His current research includes physical and technological problems in the field of high-power devices, namely the technology of copper contacts.

Vladimir Komarnitskij was born in Ukraine in 1980. In 2002, he graduated Chernivtsy National University, Ukraine, from the specialization physics electronics. He received Ph.D. degree in Electronics from FEE-CTU in 2006. He is currently working as a postdoc in the Electron Device Group. His research is in the field of radiation defects in semiconductors and characterization of quantum structures.

Jiří Kroutil was born in Tábor in 1980. He graduated in Microelectronics from the CTU-FEE in Prague in 2005. Since 2005 he is a PhD student at the Department of Microelectronic. He is a member of the Microsystems group. His work is focused on inteligent microsystem structures.

Alexandr Laposa was born in Pardubice in 1978. He graduated in Automation and Computer Science from Faculty of Mechanical Engineering from Brno University of Technology. He is working towards his Ph.D. in Microsystems Group. His work is concentrated on inteligent microsystem structures.

Tomáš Teplý was born in Chrudim in 1979. He graduated in Microelectronics from the FEE-CTU in Prague in 2005. He is working towards his PhD in the Microsystems group. His work is concentrated on simulation and optimization of microsystems. Since October 2005 he is part-time research fellow at the Department.

Tomáš Třebický was born in Žatec in 1980. He graduated in Microelectronics from the FEE-CTU in Prague in 2004. He is working towards his Ph.D. in the Electron Device Group. His work is concetrated on the simulation of quantum devices.

Tomáš Vítek was born in Opava in 1980. He graduated in Microelectronics from the FEE-CTU in Prague in 2005. Since March 2005 he is a PhD student at the Department of Microelectronic. He is a member of the Microsystems group. His work is focused on microsystems and security systems. Since October 2005 he is part-time research fellow in the Department.

Hana Kubátová was born in Český Brod in 1941. She graduated from Secondary Business School in 1958. She joined the Department of Microelectronics in 1977. Since that she has been in charge of organisational and administrative work of the Department, mainly as the Departments secretary. At present, she is the Secretary of the Head of the Department.

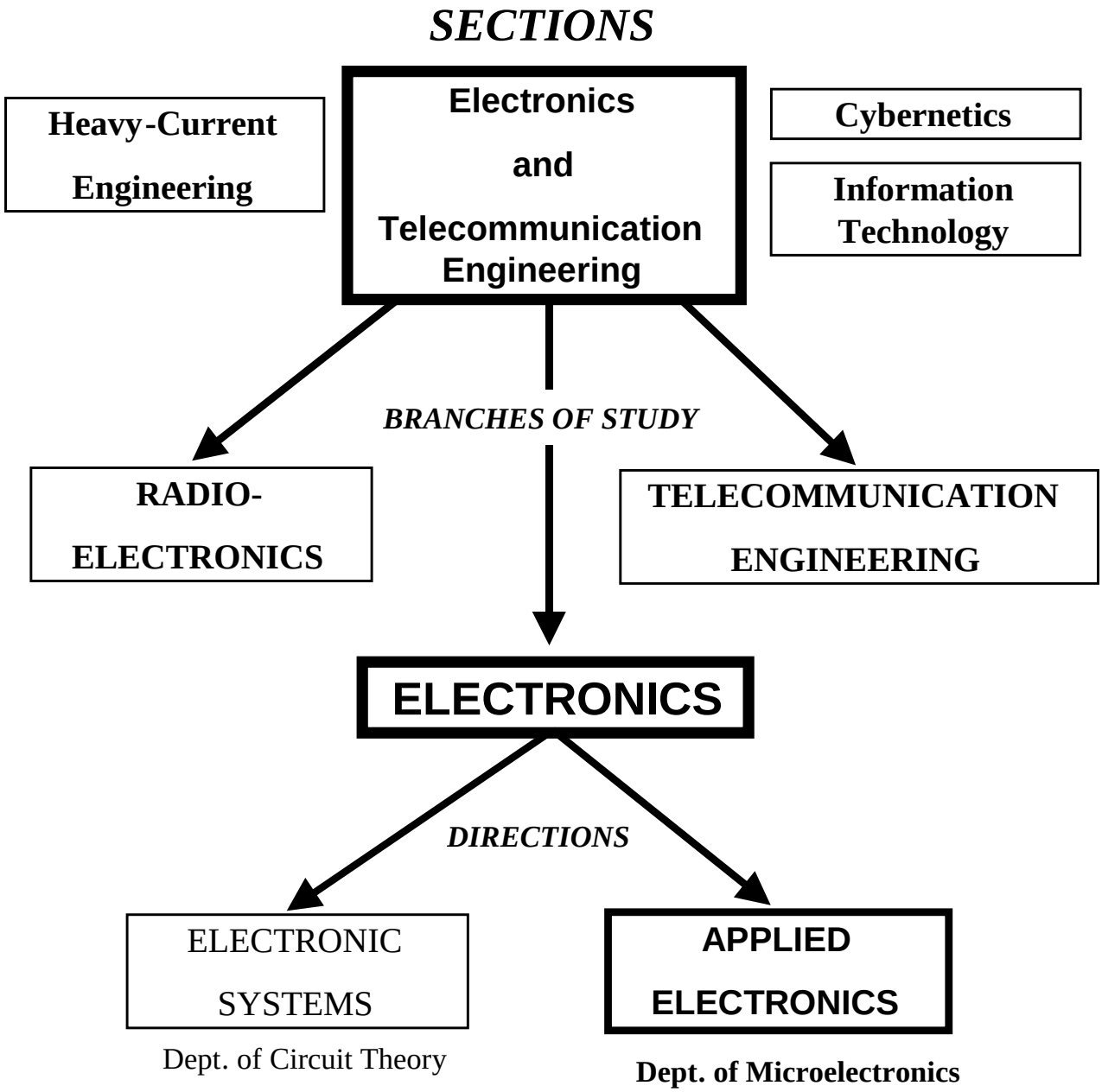
Renáta Burianová was born in Prague in 1960. She graduated from grammar school in 1979 and Secondary school for librarians in 1981. She joined the Department of Microelectronics in September, 1981. From that time she has been in charge of administrative work of the Department.

Lubomír Kafka was born in 1943. He attended the grammar school from 1958 to 1961. From 1961 to 1963 he studied the secondary school on "Mechanic of electronic equipments". In 1965 he joined the CTU in Prague as a technician. At present, he is working as a technician in the Department. He is responsible for teaching laboratories. He is engaged in mechanical and electronic service.

Miroslav Horník was born in Prague in 1946. He graduated in 1966 at a Secondary school specialized in Machinery engineering in Prague. He joined CTU Prague, then the Institute of Physics, Czechoslovak Academy of Science and, nowadays, he is working in the Department as a technician. He provides repair and service of miscellaneous tools and equipments.

UNDERGRADUATE TEACHING

Organization of study at the Faculty of Electrical Engineering



BRANCH OF STUDY ELECTRONICS

The objective of the electronic branch of study is to educate electrical engineers competent to solve problems concerning the wide spectrum of the structure of electrical industry and also extending to the field of information and computing technology, ecology, health care, mechanical engineering, robotics, etc.

The study involves the necessary theoretical introduction into subjects that provide general education for an electrical engineer which is followed by specialized courses. As to specialized orientation, the stress is laid on electronic components, semiconductor structures, digital and analog electronic circuits, microelectronics, application specific integrated circuit design, microcomputers, signals and electronic systems, sensors, sensor systems, design of electronic equipment, integrated and coherent optics, radiation sources and detectors, applications of optoelectronics and telecommunication systems. The study of the applied electronics and electronic systems aims to prepare engineers who are able to solve problems of the applications of integrated circuits and of the special electronic structures and systems, as well as the electronic instrumentation design. The students master the digital signal processing methods and the implementation of algorithms in the special processor systems.

The optional subjects in the higher terms provide the students an opportunity of individual choice of their further specialization emphasizing the applications of electronics and optoelectronics.

The topics of lectures, laboratory and seminar exercises have been selected so that a student can master the reported stuff perfectly also in practice. The Department of Microelectronics endeavors to give the students, especially those with excellent results, the possibility of satisfying their professional ambition home, as well as abroad. The graduates are also offered a possibility of further postgraduate (Ph.D) studies. We believe that the graduates of our specialization will find good jobs in the industry of developed countries.

COURSES DELIVERED BY THE DEPARTMENT
In summer semester 2007/2008

Courses in Czech – new curriculum

Course Code	Course Name	Lectures and exercises in hours per week
X34BAP	Bachelor Project	0+5
X34BPJ	Semestral Project	2+2
X34ELE	Electronics	2+2
X34ESS	Electronic Devices and Structures	2+2
X34FOT	Photonics	2+2
X34NZE	Design of Power Supplies for Electronics	2+2
X34SEE	Sensors in Electronics	2+2

Course in Czech – old curriculum

Course Code	Course Name	Lectures and exercises in hours per week
34APS	Applications of Modern Devices	2+2
34BP	Bachelor Project	0+4
34DP	Diploma Project	0+14
34DS	Diploma Seminar	0+4
34EL	Electronics	2+2
34EPO	Physics of Semiconductor Devices	3+2
34EZS	Electronic Security Systems	2+2
34LBR	Practices in Laboratories of Electronics	0+4
34MPC	Microcomputers	2+2
34MPS	Device Interconnection Techniques	1+3
34NIO	Design of custom Ics	2+2
34NNZ	Design of Power Supplies	2+2
34NSE	New Trends in Electronics	3+2
34NVL	Design of VLSI Circuits	2+2
34POP	Practices in Optoelectronics	0+4
34PRS	Programable Devices	2+2
34SEM	Semestral Project	0+4
34SP	Semestral Project	0+4
34TCE	TCAD for Electronics	2+2

Courses in English

Course Code	Course Name	Lectures and exercises in hours per week
XE34ELE	Electronics	2+2
XE34ESS	Electronic Devices and Structures	2+2
XE34FPV	Photonic receivers and transmitters	2+2
XE34TCA	TCAD	2+2

Courses for Ph.D. students

Course Code	Course Name	Lectures and exercises in hours per week
XP34APD	Modern Power Semiconductor Devices	3+0
XP34AT	Application of TCAD tools	2+1
XP34CNO	Crystal optics and Non-linear Optics	3+0
XP34ETS	Electrical Transport in Semiconductors	2+2
XP34MSY	Microsystems	3+0
XP34ORD	Radiation Sources and Detectors	3+0
XP34PED	Advanced Electronic Devices	3+0
XP34SRS	Semiconductor Radiation Sources	3+0
XP34TOS	Technology of Optoelectronic Structures	3+0

Courses for vocational students

Course Code	Course Name	Lectures and exercises in hours per week
D34SP	Semestral Project	0+4
XD34BAP	Bachelor Project	0+15
XD34ELE	Electronics	14+6
XD34ESS	Electronic Devices and Structures	14+6
XD34FOT	Photonics	14+6

COURSES GIVEN BY THE DEPARTMENT
In winter semester 2008/2009

Courses in Czech – new curriculum

Course Code	Course Name	Lectures and exercises in hours per week
X34BPJ	Semestral Project	2+2
X34EPO	Physics of Semiconductor Devices	2+2
X34MPC	Microcomputers	1+2
X34NNZ	Design of Power Supplies	2+1
X34NZE	Design of Power Supplies for electronics	2+2
X34PPN	Principles and Rules of Electronic Design	1+2
X34SIO	Structures of Integrated Circuits	2+2

Courses in Czech – old curriculum

Course Code	Course Name	Lectures and exercises in hours per week
34AVS	Application of Power Semiconductor Devices	2+2
34BP	Bachelor Project	0+4
34DP	Diploma Project	0+14
34DS	Diploma Seminar	0+4
34LBR	Practices in Laboratories of Electronics	0+4
34MIK	Microelectronics	2+2
34MPS	Device interconnection Techniques	1+3
34OP2	Optoelectronics II.	3+2
34PN	Practice of IC Design	1+3
34POP	Practice of Optoelectronics	0+4
34SEM	Semestral Project	0+4
34SP	Semestral Project	0+4
34ZZD	Radiation Sources and Detectors	2+2

Courses in English

Course Code	Course Name	Lectures and exercises in hours per week
XE34ELE	Electronics	2+2
XE34EPO	Physics of Semiconductor Devices	2+2
XE34ESS	Electronic Devices and Structures	2+2
XE34SIO	Structures of Integrated Circuits	2+2

Courses for Ph.D. students

Course Code	Course Name	Lectures and exercises in hours per week
XP34APD	Modern Power Semiconductor Devices	3+0
XP34CNO	Crystal optics and Non-linear Optics	3+0
XP34ETS	Electrical Transport in Semiconductors	2+2
XP34IO	Integrated Optics	3+0
XP34MSY	Microsystems	3+0
XP34PED	Advanced Electronic Devices	3+0
XP34PIC	Design of Programmable Integrated Circuits	4+0
XP34STV	Structures and Technology of VLSI	4+0
XP34TOS	Technology for Optoelectronics	3+0

Courses for vocational srudents

Course Code	Course Name	Lectures and exercises in hours per week
D34SP	Semester Project	0+4
XD34BPJ	Semestral Project	14+6

A BRIEF DESCRIPTION OF COURSES DELIVERED BY THE DEPARTMENT

Electronics, BSc

Lectures given by J. Foit and J. Vobecký

Semiconductors. PN junction, diodes, Schottky diode. Rectifiers. Bipolar transistors, biasing circuits. JFET and MOSFET, biasing circuits. Small signal amplifier, power amplifier. Switching circuits. Power amplifier classes. Thyristor, latch-up. Operational Amplifiers – negative and positive feedback, basic circuits. Optoelectronics – LED, laser, photodiode, phototransistor, photoresistor. Introduction to digital technique – CMOS, LSTTL.

Electron Devices, BSc

Lectures given by L. Jirásek

Diodes, unipolar and bipolar transistors, switching, optoelectronic and passive components, vacuum tubes. Physical mechanisms, principles of device operation, properties, characteristics, parameters and models of devices. Basic circuits, recommended applications, switching operation. Noise parameters. Basic structures of integrated circuits. Computer modeling and experimental verification.

Photonics, BSc

Lectures given by Z. Burian

The major aim of these lectures is to explain the principles and using of the main parts of modern optical systems, both from the theoretical and application point of view. Measurement methods for optoelectronics are presented. The part of lectures is devoted to optical display structures, optical processors and to the image processing.

Power Supplies in Electronics, BSc

Lectures given by M. Husák, F. Vaníček

Rectifiers. Stabilisers - parametric, with continuous control. IC voltage regulators. Fly-back converter. Forward converter. Push-pull converter, double forward converter. Monolithic regulators. EMC. Over current protection. Over voltage, under voltage, output reverse voltage protection. Overload and thermal protection. Batteries, solar battery, accumulator, chargers. References.

Microcomputers, BSc

Lectures given by T. Teplý

Microchip PIC18F252 family. I/O tasks, programmable peripheral ICs. Development and debugging tools. Design and programming of instruments and systems based on single-chip computers. Individual students' projects.

Microelectronics, BSc

Lectures given by J. Jakovenko

Basic functional structures of ICs. Passive and active elements. Technological process. Bipolar and unipolar structures. Logic integrated circuits, VLSI circuit systems. Analogue integrated circuits. Design of vertical structure, layout, design rules. System of IC process quality control. IC functional and parametric testing, test structures, yield and reliability.

Optoelectronics I, BSc

Lectures given by V. Jeřábek

Basic principles of optoelectronics. Planar and fiber optical waveguides. Semiconductor lasers and LEDs. Semiconductor light detectors. Structures for distribution and harnessing of optical radiation. Optoelectronic processors. Optical communication systems. Optical amplifiers. Display devices. Optical memories. Optical fiber sensors. Integrated optical and photonic structures.

Sensor Systems, BSc

Lectures given by M. Husák

Sensor - classification, materials, production. General characteristics - static and dynamic parameters, errors, noise, linearisation, calibration. Microelectronic sensors materials, physical principles, design, integration. Temperature sensors, pressure sensors, SAW sensors, optoelectronic sensors, fibre optic sensors. Radiation sensors. Magnetosensors. Chemical sensors, biosensors. Humidity sensors. Flow meters. Level sensors. Sensor signals processing. Smart sensors. Application of sensors.

Physics of Semiconductor Devices, MSc

Lectures given by J. Voves

Semiconductor crystal lattices, band structure of semiconductors, statistical distributions, charge transport, scattering mechanisms, non-equilibrium carrier densities, non-homogeneous semiconductor systems, heterostructures, physics of bipolar and unipolar devices, semiconductor sources and detectors of radiation, laser physics, low dimensional structures.

Design of Integrated Circuits, MSc

Lectures given by J. Jakovenko

Importance of ICs. Economic aspects of IC. Design methodologies: gate arrays, standard cells and functional blocks, full custom design. Design hierarchy: behavioural description, logic and electric design, simulation, layout capture and verification. CAD tools for IC design: HDL, front end tools, simulators, layout editors, structural synthesis, silicon compilers. IC testing.

Sensors in Security Systems, MSc

Lectures given by M. Husák

Security, safety and multi-channel systems. Dynamic analysis and optimisation. Signal interference and system internal noise. Input quantities. Analog and digital signal processing, conversions. Signal representation and sensor signal code. System calibration. Communication in system, interface. Output unit - communication, indication, registration, protection, switch, local and remote control, actuators.

Optoelectronics II, MSc

Lectures given by Z. Burian

Optocouplers. Sensors (spectral, amplitude, interferometric, polarimetric). Distributed fiber-optics sensors. Fiber-optics communications, components of the optical fiber link, modulation. Modulation, multiplexing and coupling. System performance. Receiver sensitivity. Coherent optical communications. Optical memories. Optical processors. Laser measuring system. Laser Doppler velocimetry. Spectral analyzers.

Application of Power Devices, MSc

Lectures given by L. Jirásek

Static and dynamic processes of power structures in forward, blocking and reverse mode of operation. Power diodes, BJTs, thyristors and special thyristor structures, field controlled power devices, HF and HV devices, power ICs, characteristics and features. Packaging and cooling, transient thermal impedance. Principles of application in power circuits, basic trigger and application circuits.

Radiation Sources and Detectors, MSc

Lectures given by Z. Burian

Optical radiation Thermal sources, electroluminescent diode. Lasers active medium, optical resonators, gas, liquid, dye, solid-state and injection lasers, laser modes: mode controlled, frequency agility, spectral width, frequency stability, amplifiers, mode locked. Photomultipliers, photoresistors, photodiodes, nonselective detectors. Optical receivers, PIN and APD coupling, optical preamplifiers.

Practice of IC Design I, MSc

Lectures given by J. Jakovenko

Main purpose of this course is to enable students to design their own integrated circuit. Students will work in groups (of 5 to 10 students) on the design project using industrial standard CAD tools (CADENCE, SYNOPSYS). Successful circuits could be fabricated via EUROPRACTICE project. The lectures will be concentrated in the first three weeks of the term and will be devoted to IC design methodologies, CAD tools, description of available libraries and design rules.

Advanced Semiconductor Technologies, MSc

Lectures given by J. Jakovenko

Electrical characteristics of processed materials. Bulk crystal growth. Oxidation. Lithography. Doping. Etching. Chemical vapour deposition. Physical vapour deposition. Ion implantation. Packaging. VLSI Processes. Microsystems. Cleanliness and purity in the process environmental.

Applications of Modern Devices, MSc

Lectures given by J. Foit

Analog devices, optimisation. Interference of different types of signal transmission, optimisation. Rules for optimisation of large arrays, power distribution, interfacing. Mixed-mode devices. Diagnostics in ADC's and DAC's, minimising residual errors. Standards for interface buses, sensors, actuators, ergonomics. Processing of small and large signals, noise, insulation.

Design of Power Supplies, MSc.

Lectures given by A. Krejčiřík

This represents extension of the subject “Power Supplies in Electronics”. The main field comprises Integrated circuits for SMPS (principles, design, verification.) Coils, transformers, regulators, synchronous rectifiers, resonance power supplies. Switcher CAD. Magnetic design Tool. Filter CAD. MicroPower Switcher CAD.

TCAD for Electronics

Lectures given by J. Voves

Principles of Technology CAD – Silvaco tools. Introduction to the ATLAS device simulator. Drift-diffusion approximation. Poisson and continuity equations. SRH model. Models of Auger, optical generation-recombination and surface recombination, impact ionization and mobility. Heat flow equation. Boundary conditions. Boltzmann transport equation. Mathematical background of simulation techniques. The practice of device simulation: diode, BJT, MOSFET. Individual projects. Hands-on principle of seminars.

Device Interconnection Techniques

Lectures given by V. Záhlava

Computer design of printed circuit boards (PCB). System OrCAD. Design rules for PCB according to EMC in analog, digital and power applications. Supply and grounding techniques. Technological processes and fabrication of PCB, classes of accuracy. Surface mount technology and devices, circuit layout process and soldering. Technological and design trends. Design of student PCB by use of PC in departments computer room.

Programmable Logic Devices

Lectures given by P. Hazdra

Programmable logic devices (PLD): types, principles, internal architecture, and production technologies. SPLDs (PAL, GAL, PLA), CPLD devices and field programmable gate arrays (FPGA): architecture of internal elements, interconnections, development systems, configuration and reconfiguration. Configurable Systems on Chip. PLD design usig VHSIC HDL (VHDL): synthesis, mapping and testing. Practical design of CPLD and FPGA using Xilinx ISE.

Design of CMOS and BiCMOS Circuits, MSc

Lectures given by J. Jakovenko

Trends in CMOS and BiCMOS technologies. Parameters of basic structures. Modeling and simulation. Parasitic structures. Design rules, layout design. CMOS and BiCMOS logic gates. Standard CMOS and BiCMOS ICs families. CMOS and EECMOS memories. PLDs, FPGAs. Analogue CMOS and BiCMOS circuits. Switched-capacitor and switched-current techniques, MOST-C filters. Comparators, operational amplifiers, OTAs.

COURSES FOR PhD. STUDENTS (IN CZECH)

Applications of TCAD Tools

Lectures given by J. Voves

Fundamentals of TCAD. Device and mixed device-circuit simulators, principles and application. ATLAS, principles and application. Semiconductor equations. Boundary conditions. Numerical methods. Models of recombination, impact ionization, mobility. Practical exercises according to individual projects on SUN workstations.

Crystaloptics and Non-linear Optics

Lectures given by J. Čtyroký

Optical medium type classification. Single- and double-axis optical anisotropy. Chiral media. Propagation of planar waves, polarisation, phase and group velocity vectors. Energy balance and reciprocity. Reflection and refraction. Electro-optical and piezoelectric tensors. Theory and design of beam handling devices.

Programmable IC Design

Lectures given by P. Hazdra

IC's, reasons for integration, processes and methods of IC design. Custom IC's, programmable IC's. PICs with AND-OR matrices (PLD). Higher grade PLD-CPLD structures; architecture, logical blocks, interconnections. Programmable gate arrays (PGA) - principles, internal architecture. LCA-type PGA, "fine grain" structures. Tools for automated PIC design. Description of the PIC by a schematic diagram. The VHDL language for CPLD and PGA. Design of basic logic blocks in CPLD and PGA structures. Methods of PIC design, distribution to blocks. Data paths analysis, timing, testability. Advanced PICs: re-configurable and mixed-mode structures. PIC choice strategy and economics of PIC-based design.

Integrated Optics

Lectures given by V. Jeřábek

Theoretical and technological principles of IO. Light propagation in dielectric waveguide structures. Methods of waveguide structures solution. Basic physical effects and interactions used for IO structures. Fabrication of dielectric waveguides and IO structures. Passive and dynamic waveguide devices. Non-linear devices. Semiconductor integrated optoelectronics.

Optical Radiation Detection and Detectors

Lectures given by Z. Burian

Electromagnetic radiation spectrum. Radiometric and photometric units. Detection of optical radiation. Ideal detector, internal and external photo-effect. Optical receivers, design principles, properties. Noise. Detectors based on external or internal photo-effect, on thermal phenomena and others. Solar cells, properties.

Advanced Electron Devices

Lectures given by J. Voves

Energy band engineering, quantum well, wire, point. 2-D electron gas devices (HEMT, MOD FET) and double-barrier resonance tunneling (RDTB, RHET) as memories, generators, multipliers etc. Heterostructures, microwave and cryotronic devices. Recording media.

Advanced Power Semiconductor Devices and ICs

Lectures given by J. Vobecký

Physical and technological principles of advanced power devices. Trends of evolution. Parameters and applications of advanced devices. Bipolar structures. MOS structures. BiMOS structures. PN diodes. Schottky diodes. BJT transistors. DMOS and IGBT transistors. Thyristors, including GTO and MCT. Secondary breakdown theory and design rules. Smart-power devices. High voltage devices, applications.

Semiconductor Radiation Sources

Lectures given by Z. Burian

Stimulated emission in semiconductors, Homogeneous junction and heterojunction. Double heterostructure lasers. Waveguide resonators, DFB structures. Types and properties of lasers. Bistable and memory devices, switches. Non-coherent LEDs. Super-LEDs. Laser injection amplifiers. Applications and measurement of various types.

Technology of Optoelectronic Structures

Lectures given by V. Jeřábek

Preparation of optoelectronic materials and structures, diagnostic and testing methods. Fabrication of semiconductor waveguides, LEDs, lasers, photodetectors and QW structures. Design and fabrication of planar dielectric waveguide structures for distribution and harnessing of optical radiation. Measuring and testing methods. Properties of various structures, practical examples.

VLSI Structures and Technologies

Lectures given by J. Jakovenko

Functional structures of integrated circuits, unipolar and BiMOS structures. 3D structures, submicron technologies. Problems associated with dimensional reduction. Memory cells. Test structures. VLSI processes. New technologies. IC design, layout, design rules. Reliability and yield. Limitations in ICs.

Electrical Transport in Semiconductors

Lectures given by J. Voves

Electrons and holes in semiconductor crystals. Boltzmann transport equation, scattering. High field transport. Quantum transport, resonant tunneling. Single electron transport, Coulomb blockade. Ballistic transport. Transport in magnetic field, quantum Hall effect.

RESEARCH ACTIVITIES

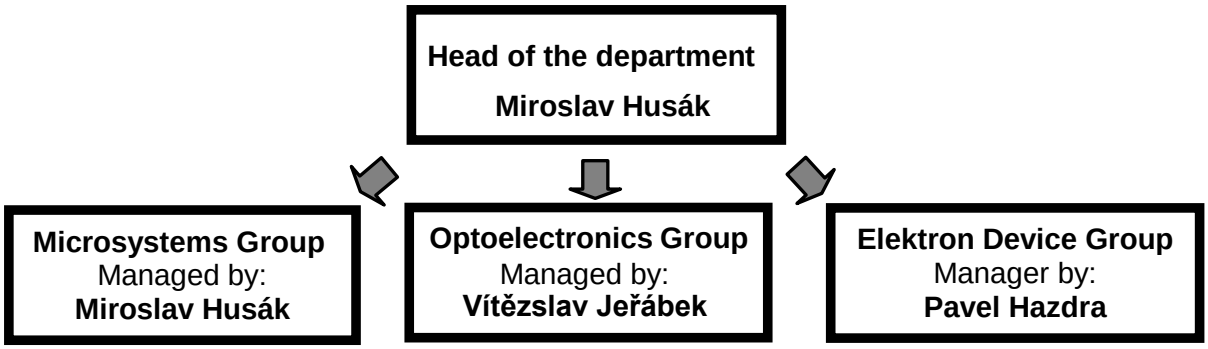
The Department has continued in research activities through grants and contracts from the Ministry of Education of the Czech Republic, Grant Agency of the Czech Republic, and CTU in Prague. A significant part of research activities was supported by the Programmes of the Ministry of Education in the following fields in alphabetical order:

- Development, Reliability and Safety of Electro-Energetic Systems,
- Information and Communication Technology,
- Methods and Systems for Measurement of Physical Quantities and Data Processing,
- Trans-Disciplinary Biomedical Engineering Research.

The international projects were those of the Framework Programmes of the European Community.

In the field of research contracts the co-operation with Robert Bosch and Magneton took place.

The research activities of the Department are focused on Electron Devices, Optoelectronics and Microsystems as listed below in the order of their date of origin. These three directions constitute the organization scheme of research in our Department and are schematically shown below. This scheme is supplemented by a brief summary of activities of individual research groups and list of their members. This is followed by the description of relevant research projects of individual research groups. The list of contracts is given as well.



MICROSYSTEMS GROUP

Head of the Research Group: M. Husák

Members: J. Foit, J. Jakovenko, V. Janíček, L. Jirásek, P. Kulha, J. Novák, A. Bouřa, P. Suchánek, T. Vítek, T. Teplý, A. Laposa, J. Kroutil, R. Teofil, K. Frýd, P.Vrchota

Research Activities:

- Modeling of Temperature and Mechan. Behaviour of Microsystem Structures
- Design of Strain Gauge Sensors for High-Temperature
- Semiconductor Microsystem Structures
- Sensor Signals Processing and Wireless Transmission
- Sensor Control Systems
- Integrated Circuit Design

ELECTRON DEVICE GROUP

Head of the Research Group: P. Hazdra

Members: J. Vobecký, J. Voves, V. Záhlava, J. Kodeš, D. Kolesnikov, V. Komarnickij, T. Třebický, M. Atef Elsayed Abdelaal.

Research Activities:

- Quantum Devices and Nanostructures
- Device and Process Simulation
- Lifetime and Defect Engineering
- Ion Irradiation
- Power Devices and Integrated Circuits
- Current Injection Capability of Microcontroller Units
- Programmable Logic Devices
- PCB Design and EMC

OPTOELECTRONICS GROUP

Head of the Research Group: V. Jeřábek

Members: Z. Burian, V. Prajzler, K. Bušek, J. A. Arciniega

Research Activities:

- Preparation and Testing of Planar Waveguides
- Analysis, Preparation and Testing of Novel Planar Electro-Optic Structures for Distribution and Harnessing of Optical Radiation
- Analysis, Preparation and Testing of Novel Devices and Integrated Planar Electro-Optic Structures for Transmitting and Receiving of Opt. Radiation
- Modeling of Electro-Optic Structures
- Research toward the Integrated Optic Circuits for Measurement and Sensor Applications

RESEARCH PROJECTS

MICROSYSTEMS GROUP

THE APPLICATION OF POLYMER ELECTRONICS TOWARDS AMBIENT INTELLIGENCE

M. Husák, V. Janíček, J. Jakovenko, P. Kulha, J. Novák

Project support: under European Commission's 6th Framework Program Nr. 507143 ***POLYAPPLY***

PolyApply aims to lay the foundations of a scalable and ubiquitously applicable communication technology. The boundary condition is the cost of the micro system, combining basic RF communication with sensor functions. The key to achieving a fundamentally different cost structure than what the evolution of existing technologies (e.g. CMOS) can achieve is to resolutely move to a disruptive new manufacturing technology: going from batch processing to in-line manufacturing technology. The semiconductor system envisaged for this end is based on polymers. Scalability refers to PolyApply's plan to develop generic technologies with a meaningful impact in the mid- to long term, rather than propose a solution for a certain generation of RF communication devices useful at one point in time. In other words, the developed technologies will lead to an extendable family of products, ranging from "simple" RF tags at ultra-low cost to RF communication devices with complex capability, such as integrated re-writable memory, sensory inputs, display, etc…

TOP AMPLIFIER RESEARCH GROUPS IN A EUROPEAN TEAM

M. Husák, V. Janíček, J. Jakovenko, P. Kulha, J. Novák

Project support: under European Commission's 6th Framework Program Nr.507893 ***TARGET***

The aim of TARGET is to overcome the current fragmentation of European research in the field of microwave power amplifiers for broadband wireless access by creating a progressive and durable integration of research capacities of the network partners. The scientific fields of TARGET - amplifier and microwave research - are central for broadband wireless access in a mobile information society. There is pressing need to develop power stage circuits and design criteria to attain the highest performances, both in terms of amplifier efficiency and linearity.

MICRO AND NANO SENSOR STRUCTURES AND SYSTEMS WITH EMBEDDED INTELLIGENCE (MINASES)
Project leader: M. Husák
Grant No. GA102/06/1624.

The goal of the proposed project is research and development of new types of intelligent integrated micro and nano sensors structures and actuators incl. electronic circuits for data signal processing and transfer. For the sensor realization will be used micro technology resources together with nano-technologies namely in the area of materials and chemical sensors and biosensors structures. Project includes modelling, properties simulation of RF MEMS switch and MEMS structure for absorptive sensor of HF emission realization, development of active integrated strain gauges and wireless, Bluetooth and ZigBee data signal transfer, development of sensors using polymeric electronic, research of new opto-chemical sensors for pollutant concentration measurement of living environment, development of micro and nano sensors for chemical and biochemical applications, build-in intelligence of integrated sensors systems, electro-magnetic compatibility in integrated circuits structures and bio-systems.

ELECTRON DEVICE GROUP

LOW-TEMPERATURE RADIATION ENHANCED DIFFUSION OF PALLADIUM AND PLATINUM
P. Hazdra, J. Vobecký
Project support: Research Centre LC06041 and Research Programme MSM 6840770014 - Ministry of Education, Youth and Sports of the Czech Republic

In this project, we compared the effect of high-energy helium implantation on guided in diffusion of platinum and palladium in the temperature range from 600 to 800°C. Local lifetime killing using this approach was then used for optimization of turn-off properties of high power PiN diodes and compared with the traditional helium implantation. The diffusion of platinum and palladium was studied on 2.5kV/100A high power diodes (area 2 cm2, thickness 370 μm) fabricated on <111> 130 Ωcm n-type float zone silicon. Diodes were removed from the standard process flow prior to the processing of contacts to sputter Pt and Pd layers at anode surface. Afterwards, 10 MeV He2+ implantation was applied through anode with a fluence of 1x1012 cm-2 on both Pt and Pd devices. This produced the maximal concentration of vacancy related defects at the end of the helium range about 70 μm from the anode surface. Diodes were then annealed for 20 minutes in vacuum at temperatures 600 - 800°C to promote the

diffusion of Pt (Pd) from surface into the position of radiation defects. The diodes processed by the new technique were compared with those subjected to standard helium irradiation.
Measurement showed that IRRM of untreated device is significantly reduced using both the standard and novel techniques. Due to the broader peak of the recombination centres and their electronic properties, the novel technique avoids a current swinging which is typical for standard He2+ implanted devices. The same reason makes the devices more resistant against dynamic avalanche, the most frequent failure mechanism, so the Pd devices survive even the turn-off above 2 kV. It was shown that all presented techniques follow the same trade-off between dynamics (IRRM) and static (VF) losses. That of the standard He2+ implantation shows very high span towards high VF and low IRRM that cannot be achieved by the diffusion techniques due to the limited solubility of either Pt or Pd at low temperatures. The advantage of the new techniques is that it gives two times lower leakage current compared to the standard He implantation for equivalent reduction of IRRM. In Pd devices, this is true in the range of optimal annealing temperatures, where the amount of Pds is higher than that of deeper levels. Together with about two time higher thermal budget and ruggedness under fast turn-off, this feature represents the third advantage of the new techniques.

THERMAL DONOR FORMATION IN SILICON ENHANCED BY HIGH ENERGY HELIUM IRRADIATION

P. Hazdra, V. V. Komarnickij

Project support: Research Centre LC06041 and Research Programme MSM 6840770014 - Ministry of Education, Youth and Sports of the Czech Republic

In this work, we studied enhanced formation of Thermal Donors (TD) in the float-zone n-type silicon irradiated with 7 MeV 4He2+ ions (doses from 5x109 to 1x1012 cm-2) and subsequently annealed up to 500°C. Resulting deep and shallow levels were characterized by DLTS and C-V measurement. Results show that helium irradiation remarkably enhances TD formation when annealing temperature exceeds 375°C, i.e. when the majority of vacancy-related recombination centres anneals out. At low doses of helium ions (below 1x1011 cm-2), the profile of radiation enhanced TD follows well the distribution of primary damage–vacancies. TD concentration is proportional to the helium dose and peaks at 1.8x1014cm-3 if annealing temperature reaches 475°C. At higher doses, annealing temperature must be increased to stimulate formation of excess TDs and TD distribution is more complex. Their growth starts from the irradiated surface and gradually extends up to the end-of-range of helium ions. Again, TD growth maximum is at 475°C and TD concentration does not overreach 2x1014cm-3. Strong enhancement of TD doping by preliminary irradiation with helium is caused by a transformation of oxygen- and vacancy

related radiation defects to TD. The excess TD generation, which is both proportional to irradiation fluence and oxygen content in the target, can substantially reduce blocking capability of irradiated devices.

OPTICAL CHARACTERISATION OF MOVPE GROWN ENGINEERED InAs/GaAs QUANTUM DOT STRUCTURES

P. Hazdra , J. Voves , J. Oswald*, K. Kuldová*, A. Hospodková*, E. Hulicius* and J. Pangrác*

*Institute of Physics, The Academy of Sciences, Prague

Project support: the grant No. 202/06/0718 of the Grant Agency of the Czech Republic, Research Programme MSM 6840770014 - Ministry of Education, Youth and Sports of the Czech Republic

In our work, we focused on photoluminescence and photomodulated reflectance characterization of various types of MOVPE grown InAs/GaAs QD structures prepared by LP MOVPE technique in an AIXTRON 200 machine using Stranski–Krastanow growth mode on semi-insulating (100) GaAs. We studied the influence of the growth conditions on the QD properties. We studied the effect of growth interruption time (GIT) change on QD properties. The growth interruption after the InAs layer growth, which is needed to complete QDs formation, was changed from 7.5 to 30 seconds. PL spectra measured at 7 K showed that emission from QD is shifted towards lower energy with increasing GIT. The PL red shift can be explained by increase of QD size with increasing GIT. These results show that QD formation is very slow process. To study corresponding change of WL thickness, we monitored optical transitions by PR measurements. Spectra were dominated by GaAs band gap bulk like signal at the energy of 1.42 eV. Below this energy the spectrum exhibited a broad resonance in the band of QDs transitions and sharp resonances corresponding to the optical transitions in the wetting layer (WL). The strongest resonance at lowest energy was attributed to e1h1 transition and the weaker one to e1lh1 transition. PR clearly showed that increasing of the GIT caused blue shift and lower splitting of e1h1 and e1l1 transitions. This means attenuation of WL thickness. To get exact magnitudes of WL thickness, we compared the measured e1h1 and e1l1 transitions with those received on ultra thin InAs quantum wells (QW) grown by the same apparatus. Result show that increasing of the GIT decreases the apparent WL thickness (from close to relaxation limit of 1.4 ML for GIT=7.5s to 1.05 ML for GIT=30s) and corresponding strain in the structure.

OPTOELECTRONICS GROUP

NEW COMPONENTS OF THE INTEGRATED OPTICS MADE BY THE PLANAR HYBRID TECHNOLOGY

Project leader: V. Jeřábek

Grant. No. GA102/06/0424

The planar photonic hybrid integrated circuits (FHIO) are the structures, which are in the current situation of quick development of the informatics and Internet very promising means for increasing the functionality of optical information systems. The subject of the research should be the processing of the theoretical model of the structure between the optoelectronic element and the channel waveguide, technology design and the implementation of the integrated structure of FHIO, which consists of the channel optical waveguide, the classical silicon-based and polymeric thin layers, and the optoelectronic element integrated on one substrate together with the optical waveguide. By the type of the integrated optoelectronic element-laser chip SS-LD(spot-size converter laser diode), waveguide photodiode WGPD and/or SS-SOA (spot-size converter semiconductor amplifier) we would obtain optoelectronic transmitter, receiver or amplifier.

RESEARCH GRANTS AND CONTRACTS

Engineering of Quantum Dots
Grant no. GACR 202/06/0718, Grant Agency of the Czech Republic
Project Manager: **P. Hazdra**

Characterization and simulation of power diodes
Freescale Semiconducteurs France S.A.S., Toulouse
Project Manager: **P. Hazdra**

Transdisciplinary Research in the Area of Biomedical Engineering II
Project Manager: **M. Husák**
Research Programme No. MSM6840770012

Research in the Area of the Prospective Information and Navigation Technologies
Project Manager: **M. Husák**
Research Programme No. MSM6840770014

Research of Methods and Systems for Measurement of Physical Quantities and Measured Data Processing
Research Programme no. MSM 6840770015, Ministry of Education
Project Manager: V. Haasz (Dept. of Measurements, FEE- CTU in Prague)
(Dept. of Microelectronics: **M. Husák**)

Modern methods of solving, design and applications of electronic circuits.
Grant No. 102/04/H105, Grant Agency of the Czech Republic
Project Manager: Z. Kolka (VUT in Brno)
(Dept. of Microelectronics: **M. Husák**)

Research, development and optimization of measuring systems and measurement uncertainty estimation by their application
Grant No. 102/05/H032 Grant Agency of the Czech Republic
Project Manager: V. Haasz (FEE CTU in Prague)
(Dept. of Microelectronics: **M. Husák**)

Structures for spintronics and quantum phenomena created by electron beam lithography
Project leader: **J. Voves**
Grant No. KAN400100652

Spintronic applications of ferromagnetic semiconductor nanostructures
Project leader: **J. Voves**
Grant No. GA102/06/0381

Optical 3D-DVD Memory Media based on New Photochromatic Polymers
Project leader: **V. Záhlava**
Grant No. 1ET310330507

EDUCATIONAL GRANTS AND CONTRACTS

Innovation of Education of Integrated Electronic System Design
The Ministry of Education, Project of the University Development Fund No. FRV886/2006
Project Manager: **P. Hazdra**

PUBLICATIONS

BOOKS (IN ENGLISH)

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JOURNALS (IN ENGLISH)

Hazdra, P. - Komarnitskyy, V.: Radiation Defects and Thermal Donors Introduced in Silicon by Hydrogen and Helium Implantation and Subsequent Annealing. Solid State Phenomena. 2008, vol. 131-133, p. 201-206. ISSN 1012-0394.

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J. Láznička	Design of Bandgap reference for IC
M. Munzberger	High Gain CMOS Amplifier Design
J. Nekvapil	Fast A/D Converter
R. Ondra	Display for the measuring of the reverse recovery time
P. Pokorný	Power Amplifier for Subwoofer Speaker
J. Shrbený	Design of Current Reference for IC
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