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 Jan Vobecký (January 2006)

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 16th 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
January 2006

Jan Vobecký
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. A. Krejčiřík, M.Sc., Ph.D. J. Novák, M.Sc. V. Prajzler, M.Sc. Z. Rozehnal, M.Sc., Ph.D. V. Záhlava, M.Sc., Ph.D.
Ph.D. students:	A. Bouřa, M.Sc. (Part-time res. fellow) J. A. Arciniega, M.Sc. J. Bláha, M.Sc. M. Hubálek, M.Sc. (PhD. 2005) R. Jackiv, M.Sc. D. Kolesnikov, M.Sc. V. Komarnickij, M.Sc. J. Kroutil, M.Sc. A. Laposa, M.Sc. F. Ondráček, M.Sc. O. Starý, M. Sc. P. Suchánek, M.Sc. R. Teofil, M.Sc.

Ph.D. students (cntd.):	T. Teplý, M.Sc. T. Třebický, M.Sc. T. Vítek, M.Sc. (Part-time res. fellow)

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.

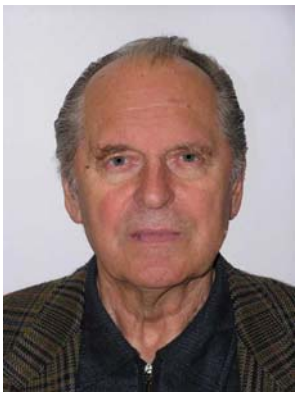
Zdeněk Burian was born in 1944. He graduated from the FEE-CTU in 1966. In 1975 he received PhD. degree. He is the author of 35 technical papers, 10 printed lectures and he owns 7 technical inventions. He is Assoc. Professor and gives lectures on optoelectronics. He is working in the field of integrated 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. More than 140 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. He is a member of Microsystems group. He is currently working towards his PhD. His research is in the field of optimization of charge process. 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.

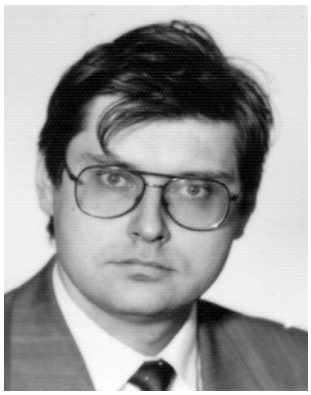
Lubor Jirásek was born in Prague in 1953. He graduated from the FEE CTU in Prague, in 1978. He received PhD. degree in Electronics in 1983. From 1978 to 1983 he was working as a Research Fellow in the area of high-power devices. He is author of 7 technical papers and 3 printed lectures. He is teaching 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. In 1998, he graduated in Microelectronics from the FEE-CTU in Prague. He started his PhD. study with the Microsystems group where he deals with 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 was born in Prague in 1976. He graduated in Microelectronics from the FEE-CTU in Prague, in 2001. He is working towards his Ph.D. Since 2005 he is an Assistant Professor at the Department. He is member of the Optoelectronics group. His work is concentrated on the fabrication and diagnostics of optical passive and active planar waveguides.



Zdeněk Rozehnal was born in Prague in 1963. He graduated in Microelectronics from the Faculty of Electrical Engineering, CTU in Prague, in 1987. At present, he is working as an Assistant Professor. He is teaching electronics, microprocessors, single-chip microcomputers, PLDs and digital technique. He is the author of 20 technical papers, 3 printed lectures and holder of two certificates of technical invention.

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 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 he is part-time research fellow at the Department.

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.

Jan Bláha was born in Prague in 1979. He graduated in Telecommunications from the FEE - CTU in Prague in 2004. He is working towards his PhD degree. His work is concentrated on the Reconfigurable systems based on Field Programmable Gate Arrays.

Milan Hubálek was born in Lanškroun in 1978. He graduated in Microelectronics from the FEE-CTU in Prague in 2002. He is working as a Ph.D. student and he is a member of the Optoelectronics group. His work is concentrated on analysis and design of optical micro-resonators. He successfully defended his PhD. work in 2005.

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. The theme of his master work was "Preparation and Properties Structures of Copper-Indium Diselenide". He is currently working as a PhD student in the Electron Device Group. His research is in the field of lifetime control and the defect characterisation of ion irradiated semiconductor devices.

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.

František Ondráček was born in Chrudim in 1977. He graduated in Microelectronics from FEE-CTU in Prague, in 2002. He is working towards his Ph.D. in the Optoelectronics group. He is teaching Electronics. His work is concentrated on the characterization of waveguide photonic structures.

Ondřej Starý was born in Prague in 1975. He graduated in Telecommunication from the FEE-CTU in Prague in 1999. Since 2003 he is a PhD student at the Department of Microelectronic and he is a member of the Microsystems group. His work is concentrated on Temperature sensitive microstructures.

Pavel Suchánek was born in in Přerov in 1979. He graduated in Microelectronics from the FEE-CTU in Prague. He is working towards his PhD in the Microsystem group. His work is concentrated on the design of electronic devices for polymer electronics. Since October 2005 he is part-time research fellow at the Department.

Rostislav Teofil was born in Český Těšín in 1979. He graduated in Physical Electronics from the Faculty of Nuclear Science and Physical Engineering – CTU 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 optoelectronic biosensors.

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.

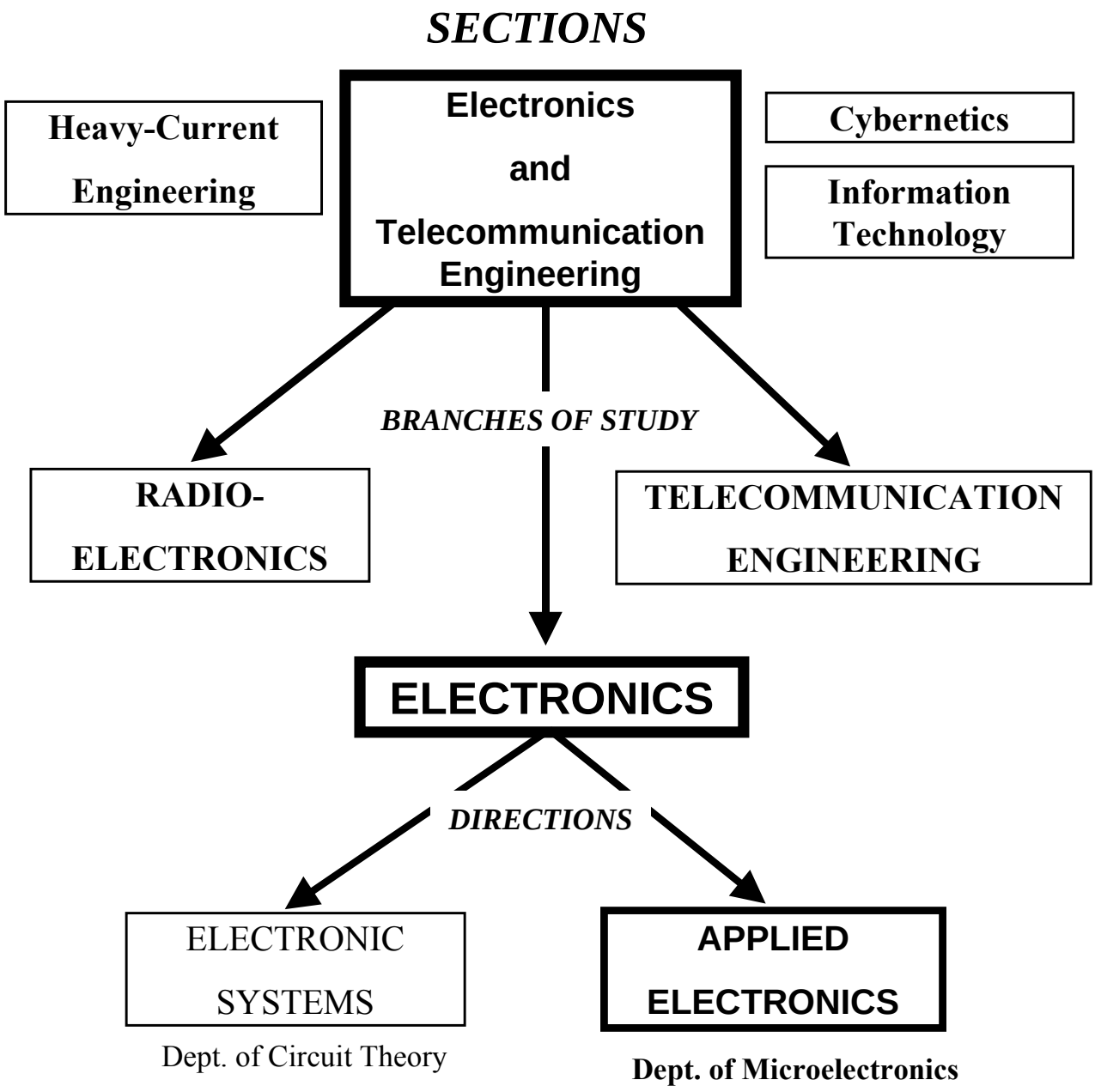
Renáta Burianová was born in Prague in 1960. She graduated from grammar school in 1979 and Secondary school for librarians in 1981. She joined the Department of Microelectronics in September, 1981. From that time she has been in charge of administrative work of the Department.

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.

At present, a completely new curriculum comprising the Bachelor, Master and Doctoral degrees is gradually coming into effect following the principles of Bologna Declaration of the European Community. In 2004, the course on Electronics was taught by our Department during the second term of the 3-years Bachelor programme for the first time. The new study scheme is about that of the old one. However, after completion the Bachelor phase, a student either moves to another University or continues in the Master study after passing exams.

CURRICULUM OF THE BACHELOR STUDY

Electronics and Communication Engineering (3 years study):

The first year of Bachelor study

Course name	Lectures and exercises in hours per week	Term / Year
Obligatory subjects:		
Mathematics I	3 + 2	Winter / 1st year
Introduction to Algebra	2 + 2	
Introduction to Electrotechnical Materials	2 + 1	
Algorithms	2 + 2	
Electrical Circuits I	2 + 1	
Physical Education I	0 + 2	
Technical Documentation	1 + 2	Win/Sum 1st year
Economy	2 + 1	
Mathematics II	2 + 2	Summer / 1st year
Electrical Circuits II	2 + 2	
Electronics - ***taught by Microelectronics Dept.***	2 + 2	
Physics I	3 + 2	
Physical Education II	0 + 2	
Choice of subject in compulsory area:		
English language	0 + 2	Winter / Summer
French language	0 + 2	
German language	0 + 2	
Russian language	0 + 2	
Spanish language	0 + 2	
Czech language (for foreign students)	0 + 2	
Seminar on Electrical Engineering	0 + 2	Winter 1st year
Seminar on Mathematics and Physics	0 + 2	

The second year of Bachelor study

Course name	Lectures and exercises in hours per week	Term / Year
Obligatory subjects:		
Physics II	2 + 2	Winter / 2nd year
Materials and Technologies for Electronics	2 + 1	
Business Management	2 + 1	
Electrical Circuits III	2 + 2	
Introduction to Computer Systems	2 + 1	
CAD in Communication Technique	2 + 1	
Electrical Measurements B	2 + 2	
Physical Education III	0 + 2	
Theory of Electromagnetic Field	2 + 2	Win/Sum 2nd year
Small Business	2 + 1	
Physical Education and Sports Summer/Winter courses		
Fundamentals of Logical Circuits	2 + 2	Summer / 2nd year
Electron Devices and structures - ***taught by Microelectronics Dept.***	2 + 2	
Signals and Systems	3 + 1	
Physical Education IV	0 + 2	
Choice of subject in compulsory area:		
English language	0 + 2	Winter / Summer 2nd year
French language	0 + 2	
German language	0 + 2	
Russian language	0 + 2	
Spanish language	0 + 2	
Mathematics 3B	2 + 2	
Design and Technology	2 + 2	
Mathematics 4B	2 + 2	
Sensors in Electronics - ***taught by Microelectronics Dept.***	2 + 2	
Multimedia and TV	2 + 2	
Antennas and Propagation – Basic Course	2 + 2	
Power Engineering - Basic Course	2 + 2	

The third year of Bachelor study

Course name	Lectures and exercises in hours per week	Term / Year
Obligatory subjects:		
Waves and Transmission Lines	2 + 2	
Electronic Circuits in Communications	2 + 2	Winter
Fundamentals and Management of Telecommunications	2 + 2	/
Project	2 + 2	3rd year
Humanities	2 + 0 or 0 + 2	
Telecommunication Systems and Networks	2 + 2	
Photonics - ***taught by Microelectronics Dept.***	2 + 2	Summer
Communication Technology – Radio Systems	2 + 2	/
Basic Measurements in Communications	1 + 2	3rd year
Humanities	2 + 0 or 0 + 2	
Bachelor Project	0 + 5	
Choice of subject in compulsory area:		
English language	0 + 2	
French language	0 + 2	
German language	0 + 2	Winter
Russian language	0 + 2	
Spanish language	0 +2	
Mathematics 3B	2 + 2	
Design and Technology	2 + 2	
Mathematics 4B	2 + 2	Winter
Sensors in Electronics - ***taught by Microelectronics D.***	2 + 2	/
Multimedia and TV	2 + 2	Summer
Antennas and Propagation – Basic Course	2 + 2	3rd year
Power Engineering - Basic Course	2 + 2	
Measurements in Communications	1 + 2	
Physical Education and Sports Summer/Winter courses		S/W

CURRICULUM OF THE BACHELOR STUDY

FACULTATIVE SUBJECTS – new curriculum

Facultative subjects offered by the Dept. of Microelectronics for the whole Faculty are as follows:

Course name	Lectures and exercises in hours per week	Term
Microelectronics Department only		
Microcomputers	1 + 2	Winter
Design of Power Supplies for Electronics	2 + 2	W/S

MSc. COURSE – old curriculum
CURRICULUM OF THE BRANCH ELECTRONICS

Obligatory and facultative subjects: (beginning from the 5th year of a study)

Course name	Hours per week	Term
Obligatory subjects:		Summer
Mathematics VI	2 + 2	
Digital signal processing	3 + 2	
Electronics of Semiconductors Microelectron. D.	3 + 2	
Facultative subjects:		
Security Systems Microelectronics Dept.	2 + 2	
Design of Integrated Circuits Microelectronics D.	2 + 2	
Architecture and Using of Programmable Circuits I	2 + 2	
Electronic Systems	2 + 2	
Obligatory subjects:		Winter
Optoelectronics II Microelectronics Dept.	3 + 2	
Analogue and Digital Systems	3 + 2	
Semestral Project	0 + 4	
Facultative subjects:		
Practices on IC Design Microelectronics Dept.	1 + 3	
Applications of Power Devices Microelectron. D.	2 + 2	
Radiation Sources and Detectors Microelectron. D	2 + 2	
Implementation of DSP	2 + 2	
Architecture and Using of Program. Circuits II	2 + 2	
Obligatory subjects:		Summer
Special digital systems.	3 + 2	
New Trends in Electronics Microelectronics Dept	3 + 2	
Diploma Seminar Microelectronics Dept	0 + 4	
Choise of subject in compulsory area::		
Algorithm of Signal Processing	2 + 2	
DSP of Speech	2 + 2	
Special Structures of Digital Systems	2 + 2	
Applications of Modern Devices	2 + 2	
Power Supply Design	2 + 2	
TCAD for Electronics	2 + 2	
Obligatory subjects:		Winter
Diploma Project Microelectronics Dept.	0 +14	
Practices in Laboratories of Electronics Micro. D.	0 + 4	
Choise of subject in compulsory area:		
Design of Analogue and Digital Mixed Signal Systems	1 + 3	
Communications in Data Networks	2 + 2	
Satellite Communication and Navigation Systems	2 + 2	

FACULTATIVE SUBJECTS – old curriculum

Facultative subjects offered by the Department of Microelectronics for the whole Faculty are as follows:

Course name	Lectures and exercises in hours per week	Term
Microelectronics Department only		
Application of Microelectronic Devices	2 + 2	Summer
Device Interconnection Techniques	3 + 1	S/W
PLD - Architecture and Application	2 + 2	Summer
Optoelectronics Practice	0 + 4	S/W

FACULTATIVE SUBJECTS OFFERED BY THE DEPARTMENT OF MICROELECTRONICS TO Ph.D. STUDENTS OF THE WHOLE FACULTY:

Course name
Advanced Semiconductor Power Devices and ICs
Applications of TCAD Tools
Crystaloptics and Nonlinear Optics
Photodetectors and Detection of Optical Radiation
Electrical Transport in Semiconductors
Integrated Optics
Microsystems
Programmable Logic Devices
Prospective Electronic Devices
Semiconductor Radiation Sources
Technology of Optoelectronic Devices
VLSI Structures and Technologies

A BRIEF DESCRIPTION OF COURSES GIVEN 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. Vobecký

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

Applications of TCAD Tools

Lectures given by J. Vobecký

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

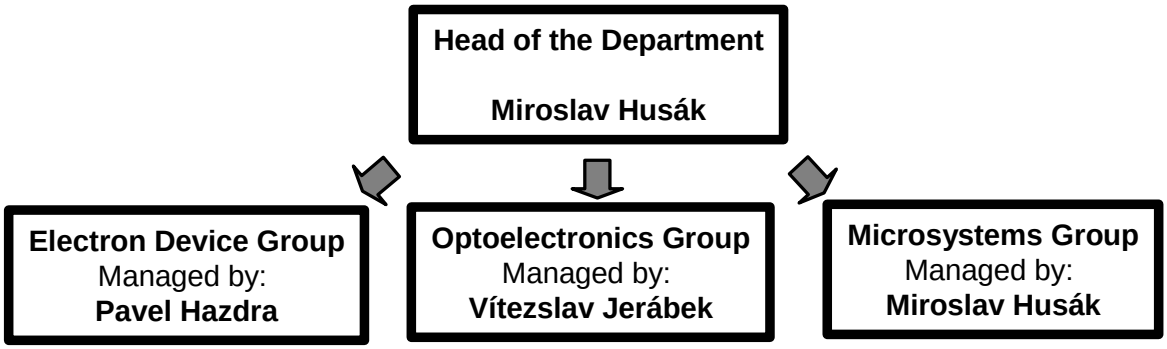
The Department has continued in research activities through grants and contracts from the Ministry of Education of the Czech Republic, Grant Agency of the Czech Republic, and CTU in Prague. A significant part of research activities was supported by the Programmes of the Ministry of Education in the following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



ELECTRON DEVICE GROUP

Head of the Research Group: P. Hazdra

Members: J. Vobecký, J. Voves, Z. Rozehnal, V. Záhlava, J. Kodeš, J. Bláha, R. Jackiv, D. Kolesnikov, V. Komarnickij, T. Třebický.

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

MICROSYSTEMS GROUP

Head of the Research Group: M. Husák

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

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

RESEARCH PROJECTS

ELECTRON DEVICE GROUP

THE NOVEL METHODS OF LOCAL LIFETIME CONTROL IN SEMICONDUCTORS

J. Vobecký, P. Hazdra

Project support: Grant no. 102/03/0456 -Grant Agency of the Czech Republic, Research Programme No. JE MSM 212300017

The third year of the project was dedicated to the local lifetime control using palladium. The decoration of radiation defects (resulting from 10 and 12 MeV alpha particle irradiation) by substitutional palladium was originally used to locally decrease the carrier lifetime in 2.5 kV/100A diode. The diffusion from palladium silicide anode contact made by sputtering and sintering was stimulated by the radiation defects during annealing in the range 600 – 800 ^{o}C. The devices annealed at 600 – 650 ^{o}C have shown very low leakage current, high thermal stability of defects and excellent softness and ruggedness under reverse recovery with dI/dt up to 700 A/μs and 2 kV dc line voltage.

PLATINUM IN-DIFFUSION CONTROLLED BY RADIATION DEFECTS FOR ADVANCED LIFETIME CONTROL IN HIGH POWER SILICON DEVICES

P. Hazdra, J. Vobecký

Project support: Research Programme no. JE MSM 6840770014, Grant no. 102/03/0456 - Grant Agency of the Czech Republic

The aim of the project is to fully control introduction and shaping of the profile of platinum substitutionals (Pt_s) – the ideal center for carrier recombination – for local lifetime killing in silicon. Platinum diffusion enhanced and controlled by radiation defects was used for this purpose. This is because lattice vacancies created by irradiation with high-energy ions capture fast-diffusing platinum interstitials and convert them to stable Pt_s. The resulting profile of recombination centers (the $Pt_s^{-/0}$ level) can be then very similar to that given by ion irradiation itself. In this way, the local lifetime control by platinum acceptors can be achieved.

In this stage of the project, we used the platinum implantation as a method to control the amount of in-diffused Pt_s. We combined it with single and multiple

energy helium irradiation and two-step annealing process. Results show that for selected optimum annealing conditions (725°C 20 minutes), the amount of in-diffused Pt_s can be controlled by the dose of platinum implantation and the shape of the profile by the radiation damage. However, concentrations of in-diffused platinum remain more than one order below the magnitudes which were obtained previously by diffusion from PtSi layer. This is because the in-diffusion from the implanted source lacks of platinum interstitials due to their stacking to the defects produced by platinum implantation. Introduction of additional annealing steps prior to helium irradiation substantially enhances the amount of Pt_s incorporated by subsequent radiation-enhanced in-diffusion. The amount of Pt_s at the peak of the radiation defects increases about an order of magnitude, the dependence of the Pt_s concentration vs. dose exhibits linear dependence and no saturation. Also the Pt_s concentration ratio in the profile peak and tail increases and the Pt_s profile become very similar to that of radiation damage caused by light ions. Therefore, this advanced process is capable to offer a nearly "arbitrary" lifetime profile controlled by $Pt_s^{-/0}$ center. The method was further applied to local lifetime control in high-power PiN diodes.

THERMAL DONORS IN SILICON IRRADIATED BY MeV ALPHAS: EFFECT OF POST-IRRADIATION ANNEALING

P. Hazdra, V. V. Komarnickij

Project support: Research Programme no. JE MSM 6840770014, Grant 102/03/0456 - Grant Agency of the Czech Republic

The aim of the project is to study negative side-effects – an enhanced shallow thermal donors (TD) formation - of lifetime killing techniques based on high energy ion irradiation. The TD formation was studied in the float-zone n-type silicon irradiated with 7 MeV He ions (doses from $5x10^9$ to $1x10^{12}$ 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 He irradiation remarkably enhances TD formation when annealing temperature exceeds 375°C, i. e. when the majority of vacancy-related recombination centers anneals out. At low He doses (below $1x10^{11}$ cm^{-2}), the profile of radiation enhanced TD follows well the distribution of primary damage – vacancies. TD concentration is proportional to He dose and peaks at $1.8x10^{14}cm^{-3}$ 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 He ions. Again, TD growth maximum is at 475°C and TD concentration does not overreach $2x10^{14}cm^{-3}$.

COPPER BASED CONTACTS FOR HIGH-POWER DEVICES

J. Vobecký, **D. Kolesnikov**
Project Support: Research Programme no. JE MSM 212300017, Grant no. 102/03/0456 - Grant Agency of the Czech Republic, Grant CTU 0407613

Copper contacts with thickness in the range 0.5 – 10 μm were compared with traditional aluminum ones in the pressed-package application. The combination of platinum silicide with copper layer giving PtSi-TiW-Ni-Cu contact stack has decreased the contact resistance compared to that of the traditional aluminum one. Electrical, thermal and mechanical properties were evaluated during thermal and power cycling experiments. The reliability of copper contacts with thickness up to 5 μm was evaluated at the level of aluminum. Further activities are concentrated on the optimization of barriers between individual layers.

CHARACTERIZATION OF ULTRATHIN InAs AND MODULATED InGaAs LAYERS IN GaAs GROWN BY MOVPE DESIGNED FOR ACTIVE LAYERS OF NIR LASERS

P. Hazdra , J. Voves , E. Hulicius[*], J. Pangrác[*], Z. Šourek[*]
[*]Institute of Physics, The Academy of Sciences, Prague
Project support: the grant No. IAA1010318 of the Grant Agency of the Academy of Sciences of the Czech Republic, Research Programme JE MSM 6840770014

Photomodulated reflectance spectroscopy (PR) in combination with photoluminescence and photocurrent measurement was used for characterization of highly strained submonolayer and supermonolayer multiple InAs quantum wells (MQW) and modulated InGaAs layers in GaAs grown by metal-organic vapor phase epitaxy (MOVPE). Structures were grown in AIXTRON 200 reactor at 500°C on (100) oriented GaAs substrate by periodic interruption of the InAs and GaAs growth. The layers were analyzed by X-ray diffraction and scanning tunneling microscopy. Origin of various PR spectral features was assigned by means of simulation of electronic states in these structures using the theoretical model accounting for influence of stress and quantum states coupling. Optical transitions between ground and excited states identified on series of structures with different modulations/thicknesses were used for interpretation of resulting electronic band structure of MQWs. Optimized modulated InGaAs layers were embedded into the AlGaAs/GaAs waveguides and used as active regions of highly efficient (~37%) near infrared (1.1μm) lasers.

DESIGN, SIMULATION AND CHARACTERISATION OF MBE GROWN SEMICONDUCTOR STRUCTURES

J. Voves, P. Hazdra, M. Cukr*, Z. Výborný*, T. Třebický, R. Jackiv
*Inst. of Physics, Academy of Sciences, Czech Republic

Quantum electronic devices based on GaAs/GaAlAs and GaAs/GaMnAs heterostructures suitable for electronic and spintronic applications (RTDs, ferromagnetic layers) are designed in the framework of this project. The design is based on the device simulation using standard TCAD tools and specific quantum equations solvers (Wingreen package based on the nonequilibrium Green functions). Devices grown by molecular beam epitaxy are prepared at the Institute of Physics, Czech Academy of Sciences in Prague. This year a new set of RTD structures and the structures with single GaMnAs layer has been simulated and characterized. The hysteresis and plateau on the RTD current-voltage characteristics are theoretically and experimentally analyzed.

OPTOELECTRONICS GROUP

FABRICATION AND PROPERTIES OF HYBRID INTEGRATED PLANAR ELECTRO-OPTICS STRUCTURES MADE OF POLYMERS AND GLASS MATERIALS

V. Jeřábek, **V. Prajzler**, I. Hüttel*, J. Špirková**, M. Míka**, P. Třešňáková**, **Z. Burian**, J. Čtyroký***, **M. Myslík, O. Hlaváč, J. Metter, K. Bušek, J. A. Orciniega, P. Seliger, F. Henkl**

* Dept. of Solid State Engineering, ICTP.
** Dept. of Inorganic Chemistry, ICTP.
*** Inst. of Radio Eng. and Electronics, Academy of Sciences, CR.
Project support: Grant Agency of the Czech Republic, No.104/03/0385.

Hybrid integrated planar electro-optic structures for transmitting and receiving of optical radiation on special substrate are quite new electro-optical devices, which are very useful for transmitting information on gigabit rates. The developed technology enables us to construct highly functional components by combining the passive function of planar lightwave circuit, made on Alumina, polymer or glass materials, and the active function of optoelectronic devices, as photodetectors PD, laser diode LD, waveguide photodiode WG-PD, spot-size converter integrated laser SS-LD and spot-size converter integrated optical amplifier SS-SOA, hybridized on a planar electro-optic structures. Our research was focused on the study of the polymer and glass materials and semiconductors elements, which can be used for development hybrid integrated electro-optics devices.

ERBIUM DOPED OPTICAL WAVEGUIDES ON CARBON AND CARBON NITRIDE BASE

Z. Burian, V. Prajzler, V. Jeřábek, I. Hüttel*, J. Čtyroký**,

* Department of Solid-State Engineering, ICTP.
** Inst. of Radio Eng. and Electronics, Academy of Sciences, CR.
Project support: Research Programmes No. JW MSM 213200014 and No. JA MSM 210000022. Grant Agency of the Czech Republic, No.104/03/0385.

The aim of the project is to fabricate and investigate carbon and carbon nitride planar waveguides on silicon substrates doped by erbium ions. Planar waveguides are created by a carbon or carbon nitride layer which is deposited in PECVD apparatus on silicon oxide layer, which provides optical shielding of the substrate and it is prepared by oxidation of silicon wafer. The present work is focused on determination of suitable conditions of technological process and on measurement of waveguides properties. We have proved that it is in principle

possible to dope the deposited layers by erbium ions so that resulting structures can be used as active waveguides as well.

FABRICATION AND INVESTIGATION OF RARE EARTH DOPED GALLIUM NITRIDE

V. Prajzler, V. Jeřábek, Z. Burian, I. Hüttel*, J. Stejskal*, J. Čtyroký**
* Department of Solid-State Engineering, ICTP.
** Inst. of Radio Eng. and Electronics, Academy of Sciences of the Czech Republic.
Project support: Research Programmes No. JW MSM 213200014 and No. JA MSM 210000022. Grant Agency of the Czech Republic, No.104/03/0385 and No. 104/03/0387.

The aim of the project is to fabricate and investigate properties of rare earth doped gallium nitride layers. Gallium nitride is a promising wide band gap direct semiconductor material for the optoelectronics applications due to the recent success of blue/green emitting solid state lasers and light emitting diodes. It was shown that the thermal quenching in RE-doped semiconductors decreases with the increasing bandgap. Therefore, wide bandgap semiconductors such as GaN are attractive hosts for the RE elements. Many RE elements have played a very important role in various optoelectronics and photonics applications, ranging from emitting elements in solid state lasers and displays to optical amplifiers. The most important RE ion is erbium. Erbium doped materials are of great interest in thin film integrated optoelectronic technology, due to their intra-4*f* emission at 1 540 nm, which is a standard telecommunication wavelength. Er-doped thin films can be used to fabricate planar optical amplifiers or lasers that can be integrated with other devices on the same chip.

STUDY OF FABRICATION OF POLYMER PLANAR WAVEGUIDES

V. Prajzler, V. Jeřábek, I. Hüttel*, **Z. Burian**, **M. Myslík, O. Hlaváč**
* Department of Solid-State Engineering, ICT.
Project support: Grant Agency of the Czech Republic, No.104/03/0385

Semiconductor materials and dielectric materials such as lithium niobate are relative expensive and the processes used to fabricate optical devices are very complicated. Polymer-based optical layers offer a low-cost alternative for inorganic optical waveguides. Optical polymers can be transparent, with low absorption loss below 0.1 dB/cm at the key communication wavelengths of 1 300 and 1 550 nm and the fabrication process is not complicated. Rare earth (RE) doped optical materials can be used for fabrication of solid state lasers and

optical amplifiers. We investigated fabrication process and optical properties of different polymer layers fabricated by spin coating.

FABRICATION AND PROPERTIES OF ACTIVE PLANAR WAVEGUIDES IN GLASS AND LITHIUM NIOBATE SUBSTRATES

V. Jeřábek, J. Špirková*, **Z. Burian**, J. Čtyroký**, L. Salavcová*, M. Míka* P. Třešňáková*, **V. Drahoš, K. Bušek, J. Metter**

* Dept. of Inorganic Chemistry, ICTP.
** Inst. of Radio Eng. and Electronics, Academy of Sciences, CR.
Project support: Research Programmes No. JW MSM 213200014 and No. JA MSM 210000022

Active channel waveguides in lithium niobate and glass substrates are perspective candidates for planar optical amplifiers for optical communications. Our research starts with experimental study of doping of lithium niobate and glass substrate with Er^{3+} ions and will be followed by fabrication of the waveguides in erbium-doped substrates. Very important task of the research is study of the relationship between the properties of the substrates, technological conditions of waveguides fabrication and of properties of the fabricated waveguides. The absorption and luminescence properties of the erbium doped channel waveguides are characterized and the optical gain is measured.

DESIGN OF FIBRE SENSOR WITH LIQUID CORE FOR CHEMICAL TRACE ANALYSIS

Z. Burian, P. Solařík
*Project support: CTU Research Programme DN MSM 212300*16

The aim of the project is the development and design of fiber optic sensor with liquid core for chemical trace analysis. A liquid core waveguide, typically consisting of small diameter tubes capable of guiding light through a liquid core by total internal reflection, can be used to extend the sensitivity of conventional absorbance spectroscopy by two or more orders of magnitude. Liquid core optical fiber waveguides are capillaries that contain a liquid core – liquid sample for spectroscopic analysis. We present a simple optic method that allows improving the sensitivity of conventional spectroscopic measurement. For long path length absorbance spectroscopy measurement in the ultraviolet and visible region the Teflon AF waveguide capillary cell for low refractive index liquids was designed. The sensor was modeled, simulated and the most suitable technology and materials were searched for.

MICROSYSTEMS GROUP

INTELLIGENT INTEGRATED MICROSENSOR FOR UV RADIATION FOR BIOMICROSYSTEM

L. Jirásek

Project support: Grant Agency of the Czech Republic, No. 102/03/0619

Development of UV radiation microsensor suitable for integration into bio-microsystem including recording and evaluation unit. It is supposed to develop microsensors for UV radiation of a few types: microsensor for detection in all UVA, UVB and UVC regions, microsensors for UVA region, UVB region and UVC region, physiological microsensor simulating skin sensitivity to dangerous UV radiation, spectral sensitive microsensor on AlGaN base for detection of radiation of different wavelengths (selected by applied voltage).

STRAIN GAUGE SENSORS FOR HIGH-TEMPERATURE APPLICATIONS

P. Kulha, M. Husák

Project support: Grant Agency of the Czech Republic, No. 102/03/0619

The aim of the project is to develop quality sensor for strain measurement that will be able to work at extreme conditions especially under high temperatures. The sensor is assumed for usage in turbine blade deformation measurement, inside an electric power generator. Sensor is based on piezoresistive effect when deformation causes the resistivity change in the active layer. The design consists in choosing suitable active layer with good sensitivity and long term parameters stability. The Coventorware software is used in design for simulation and verification. The sensor would be part microsystem with wireless information transmission.

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. SiityScalability 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.

DESIGN OF MICROMECHANICAL POWER SENSOR

J. Jakovenko, M. Husák

Project support: Grant Agency of the Czech Republic, No. 102/03/0619

Project is focused on thermo mechanical simulations performed with the aim to optimize the temperature distribution of the Microwave Power Sensor (MPS) microsystem keeping the thermal stress as low as possible. The concept of the absorbed power measurement is based on a thermal conversion, where the dissipated or absorbed RF power is converted into the thermal power, inside a thermally isolated system, so called the Micromechanical Thermal Converter (MTC) device. A new MTC approach uses a GaAs with an active HEMT (High Electron Mobility Transistor) heater. New technology of low stress Polyimide has been used for MTC thermal isolation.

ELECTROMAGNETIC COMPATIBILITY IN MICROSYSTEM DESIGN

J. Novák, J. Foit

Project support: Grant Agency of the Czech Republic, No. 102/03/0619

The project was targeted at creating a set of design rules for digital integrated circuits (especially VLSI type) and Microsystems, in terms of both the passive and active electromagnetic compatibility (EMC). The problem was first treated theoretically, by modeling the properties of several typical representatives of internal integrated circuit and/or microsystem layout. To verify the correctness of the theoretical analyses, an integrated VLSI monolithic test structure was designed and custom-produced in 0.5 μm CMOS technology (in Europractice IMEC, Belgium) and subjected to comprehensive measurements for EMC. The measurement results on the test structure confirmed fully the theoretical analysis and, as a final result, the targeted set of design rules was formulated.

RESEARCH GRANTS AND CONTRACTS

New Technologies for Passive and Active Planar Structures on Carbon Base and Organic Materials for Active Structures for Integrated Optics,
Project no.104/03/0385, Grant Agency of Czech Republic
Project Manager: I. Hüttel (Institute of Chemical Technology, Prague)
(Dept. of Microelectronic: **Z. Burian**)

Radiative Recombination Mechanism of Subnanometric InAs/GaAs Laser Structures
Grant no. IAA1010318, Grant Agency of the Academy of Scieneces of the Czech Republic
Project Manager: **P. Hazdra**

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**)

Integrated Intelligent Microsensors and Microsystems
Grant no. 102/03/0619, Grant Agency of the Czech Republic
Project Manager: **M. Husák**

Trans-Disciplinary Biomedical Engineering Research
Research Programme no. MSM 6840770012, Ministry of Education
Project Manager: Konvičková (Faculty of Mechanical Eng., CTU in Prague)
(Dept. of Microelectronics: **M. Husák**)

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**)

Electrical Connection of PCB-Contact of Position Sensor of Electronic Accelerator FPM1.2
Robert BOSCH spol. s r.o. , České Budějovice
Project Manager: **M. Husák**

Novel Methods of Local Lifetime Control in Semiconductors
Grant no. 102/03/0456, Grant Agency of the Czech Republic
Project Manager: **J. Vobecký**

Development, Reliability and Safety of Electro-Energetic Systems Research Programme no. JE MSM 68407700017, Ministry of Education
Project Manager: J. Tlustý (Dept. of Electronergetics, FEE- CTU in Prague)
(Dept. of Microelectronics: **J. Vobecký**)

Testing of Zener Diodes
Magneton a. s., Kroměříž
Project Manager: **J. Vobecký**

Information Technologies, Research Project of the Ministry of Education
Research Programme no. MSM 6840770014, Ministry of Education
Project manager: J. Vejražka (Dept. of Radioelectronics, FEE- CTU in Prague)
(Dept. of Microelectronics: **J. Voves**)

Optical 3D-DVD Memory Media Based on New Photochromatic Polymers
Grant no. 1ET310330507, Information Society Programme
Project Manager: **Z. Rozehnal**, replaced by **V. Záhlava**

EDUCATIONAL GRANTS AND CONTRACTS

Innovation of Education Subjects with Focus on Electronic Devices and Their Applications
The Ministry of Education, Project of the University Development Fund No. FRV2565/2005
Project Manager: **M. Husák**

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DIPLOMA WORKS (In Czech)

Defended Diploma Works Awarded by Dean of the Faculty

TYPL Pavel	Video signal processing using FPGA,
KREJSA Jan	Implementation of Wireless Communication of Microprocessors in the 2.4 GHz Band

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Defended Diploma Works

BORTEL Radoslav	The Estimation of Coherence Between EMG and EEG
DOLÍVKA Lukáš	Measurement and Simulation of Circuits with Switched Capacitors
CHALOUPKA Zdeněk	The Analysys of Speech Faults by Methods of Parametrization and Segmentation
KOBLIHA Ondřej	Internet Application for the Support of Education of Electric Filters for Electronic Circuits
KONOPKA Ondřej	Study of Influence of Separation of EEG Signals on the Classification of Motion
MACHOVSKÝ Tomáš	Detectors of Speech Activity in Real Systems with Voice Output
RUČKAY Lukáš	Implementation of IIR Filter – Biquadratic Section – on FPGA
SKIBA Michal	Electronic Meter of Altitude and Barometr with Auto-Calibration
TEPLÝ Tomáš	Contactless System for Identification and Access with Remote Administration
TUŠEK Jan	Thermostat with Peltie Cell
VÍTEK Tomáš	Model for the Protection of Small Object

DAŠEK Jiří	Low Frequency Power Amplifier
KARMAZÍN Roman	Implementation of Sound Filters Using DSP 56800
KROUTIL Jiří	Electronic Protection of a House Using GSM
MATĚJKA Miloš	Application of GSM Network for Electronic Protection of a Car
STRUHOVSKÝ Petr	Driver of String Tensometric Sensors
TARABA Martin	Methods of Automated Phonetic Labeling of Speech Database