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 (February 2004)

FOREWORD

The Department of Microelectronics belongs to The Faculty of Electrical Engineering (FEE) that is one of the five 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 26 years more than 1000 students graduated in the branch of Microelectronics and 32 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, in the frame of the NATO Science for Peace programme, and the Fifth Framework Programmes of the European Community, namely in the Programme Access to Research Infrastructure Improving the Human Potential.

The Department gives a high priority to collaborative research with industry. In 2003 year, several research contracts were signed with MOTOROLA and ON-Semiconductor.

This brochure is the 14th annual review of our Department. The contents of this report emphasise our effort for continuing the close association of teaching, research and co-operation with external subjects at both national and international levels.

Prague
February 2004

Jan Vobecký
Editor

STAFF OF THE DEPARTMENT

Head of the Department:	M. Husák, M.Sc., Ph.D.
Deputy:	J. Schrőfel, M. Sc., Ph.D., DrSc.

Professors:	M. Husák, M.Sc., Ph.D. J. Kodeš, M.Sc., Ph.D., DrSc. 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. J. Schrőfel, M.Sc., Ph.D., DrSc. 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. L. Jirásek, M.Sc., Ph.D. A. Krejčiřík, M.Sc., Ph.D. Z. Rozehnal, M.Sc., Ph.D. V. Záhlava, M.Sc., Ph.D. V. Janíček, M.Sc. J. Novák, M.Sc.
Ph.D. students:	P. Čapek, M.Sc. T. Harviš, M.Sc. M. Hubálek, M.Sc. R. Jackiv, M.Sc. D. Kolesnikov, M.Sc. V. Komarnickij, M.Sc. P. Kulha, M.Sc. A. Mačkal, M.Sc. F. Ondráček, M.Sc. V. Prajzler, M.Sc. M. Sawalmeh M. Seidenglanz, M.Sc. P. Solařík, M.Sc. O. Starý, M. Sc. J. Švorc, M.Sc.

O. Telezhnikova, M.Sc.

SUPPORT STAFF

Administration

R. Burianová
H. Kubátová

Teaching Laboratories:

L. Kafka

Technical Service: M. Horník

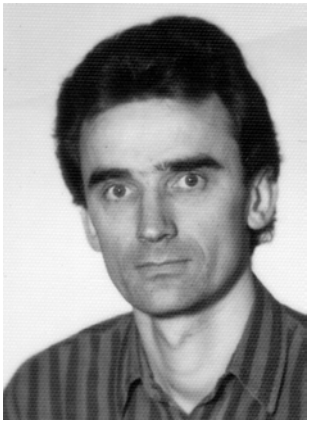
Military Service (duty to compensate):

V. Jeníček

ABOUT THE STAFF

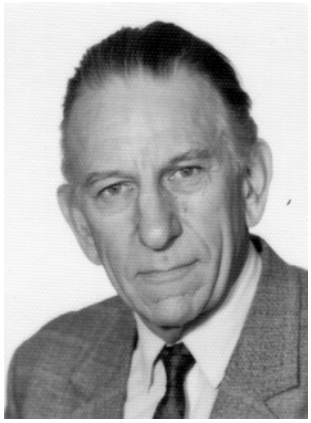
Miroslav Husák was born in Kladno in 1953. He graduated in Radioengineering from FEE-CTU in Prague in 1978. Ph.D. in 1985, Assoc. Professor in 1997, Full Professor in 2000. Manager of Microsystems Group. Author or co-author 4 lecture notes and more than 120 scientific and technical papers. Research in 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 was born in 1957 in Prague. He graduated in Electrotechnology from the FEE-CTU in 1981. PhD. degree in 1988, Assoc. Professor in 1992, DrSc. degree in 1999, Full Professor in 2000. In 1988, 1989/90, and 1993 visiting fellow in the Univ. of Uppsala, and MOTOROLA Toulouse, resp. Author and reviewer of many scientific papers, 2 patents, one textbook and 8 printed lectures. Teaching: Electronics, TCAD and Modern Power Devices. Research: Power devices & ICs, Si technology. Senior Member IEEE. Chairmen of the 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.



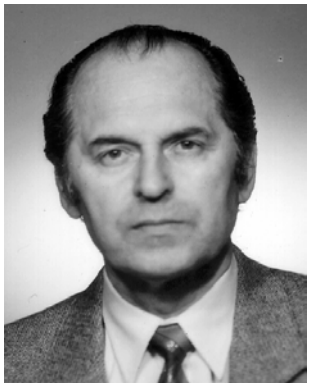
Julius Foit was born in 1932. He received MSc., PhD. and Ass. Prof. degrees in Radar Engineering, Colour TV Eng. and Multiphase Signal Processing from the CTU in Prague in 1954, 1961 and 1978, resp.. Dean of the Faculty in the University of Maiduguri, Nigeria in 1987-1989 and B. Tech. Programme Coordinator 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 and characterization (DLTS, etc.). Manager of the Electron Device Group. More than 100 scientific and technical papers, 2 patents and printed lectures. SM IEEE and chairmen IEEE EDS in the Czech Republic.

Josef Schrőfel was born in 1933. He graduated from FEE-CTU in Prague in 1956. PhD. degree from STU Bratislava in 1972, D.Sc. degree from CTU in Prague in 1994, and Assoc. Professorship in 1996. In 1974-1990 he was with Tesla Research Inst., Prague, working in research on electronic components, thin-films, solid state surface phenomena and semiconductors. Since 1975 his field is optoelectronics, optical fibres and integrated optics. He is the author of about 120 papers, 17 patents, 2 monographs and 3 books. Member of IEEE and EOS.

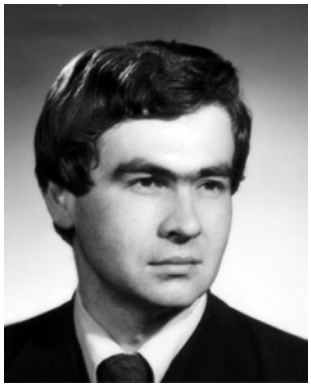
Miroslava Šemberová was born in 1939. She graduated in Radioelectronics from the FEE-CTU in Prague, in 1961. She received PhD. degree in 1973 and Associate Professorship in 1985. She is author of 12 technical papers and 10 printed lectures. She gave lectures in the area of electronic and microelectronic 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.



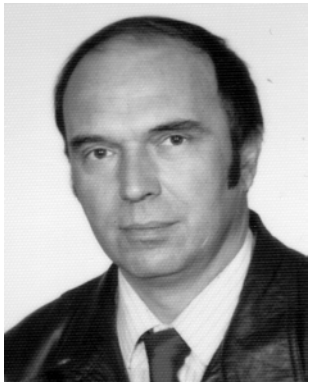
František Vaníček was born in 1936. He graduated in Radioelectronics from the FEE-CTU in Prague, in 1960. PhD. in 1972 and Assoc. Professorship in 1978. From 1972 to 1975 he gave lectures in MTC Kahira, Egypt, and from 1981 to 1983 in HIE Beni Walid, Lybia. He is the author of 15 techn. papers and 10 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.

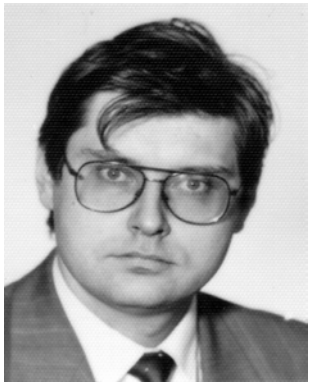


Lubor Jirásek was born in Prague in 1953. He graduated from the FEE CTU in Prague, in 1978. He received PhD. degree in Electronics in 1983. From 1978 to 1983 he was working as a Research Fellow in the area of high-power devices. He is author of 7 technical papers and 3 printed lectures. He is teaching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

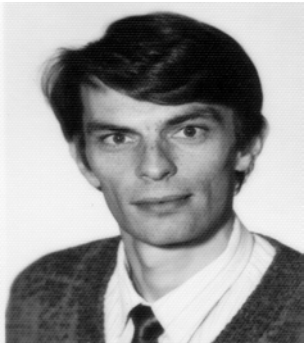
Jiří Jakovenko was born in Prague in 1972. He graduated in Microelectronics from FEE-CTU in Prague. He started his PhD. study with Microsystems group where he deals with the MEMS design and modeling. In 1998 he spent four months in Hogeschool Gent in the frame of TEMPUS programme. Since 1999 he is an Assistant Professor at the Department. He is teaching Electronics and IC Design. He is a member of the Academic Senate of the Faculty.



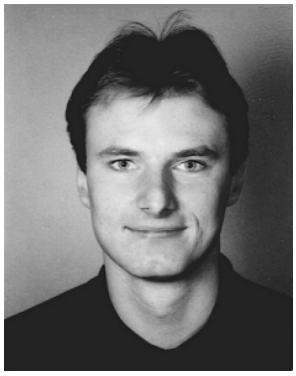
Alexandr Krejčiřík was born in 1947. He graduated in Electrotechnology from the Faculty of Electrical Engineering, CTU in Prague, in 1971. He received PhD. degree in Mathematics and Physics – branch Semiconductors. He is the author of 10 technical papers, 21 printed lectures and 6 textbooks. He is teaching courses on Electronics, Power supplies and Computer Peripherals.



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 3 textbooks, several printed lectures for students, and technical papers on power devices.



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 takes care of the Department's computer network.

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.

Pavel Čapek was born in Prague 13.3.1977. He graduated in Microelectronics from the FEE-CTU in Prague in 2001. He is working towards his Ph.D. in the field of active integrated optical waveguides. He is member of the Optoelectronics group.

Tomáš Harviš was born in 1978. He graduated in Microelectronics from the FEE-CTU in Prague in 2003. He is working towards his Ph.D. in the field of opto-chemical sensors especially in the infrared and ultraviolet region.

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.

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 Clorine." 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. The theme of 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 local lifetime control and contact properties.

Vladimir Komarnitskyy 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 working as a PhD student in the Electron Device Group in the field of lifetime control and the defect characterisation of ion irradiated semiconductor devices.

Pavel Kulha was born in Písek in 1978. He graduated in Microelectronics from the FEE-CTU in Prague. He is working towards his PhD in the Microsystems group. His work is concentrated on microsensors and microsystems for high temperature applications.

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.

Adam Mačkal was born in Kaplice in 1976. He gradated in Microelectronics from the FEE CTU in Prague in 2001. In 1999-2001 visiting student at Bournemouth University. He is working towards his Ph.D. in the Electron Device Group. He is the member of IEEE and LEOS.

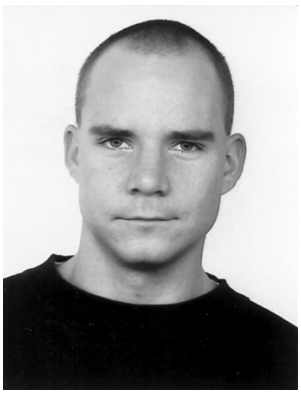
Václav Prajzler was born in Praha in 1976. He graduated in Microelectronics from the FEE-CTU in Prague, in 2001. He is working towards his Ph.D. He is member of the Optoelectronics group. His work is concentrated on the fabrication and diagnostics of optical passive and active planar waveguides.

Mohammed R. D. Sawalmeh was born in Nablus, Palestine, in 1972. In 1999, he graduated in Industrial Electronics from West Bohemia University in Czech Republic. The theme of his master thesis was "Control of Step-Motor for Robot Merlin". He is currently working as a PhD student in the Electron Device Group. His current research is in the field of nanometer semiconductor devices.

Miroslav Seidenglanz was born in České Budějovice in 1978. He graduated in Microelectronics from the FEE-CTU in Prague in 2003. He is working towards his PhD in the Microsystems group. His work is concentrated on microstructures for electro-acoustic applications.

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.

Petr Solařík was born in 1973 in Kyjov. He graduated in Microelectronics from the FEE -CTU in Prague, in 2000 . At present he is PhD. student at the Department of Microelectronics. He is a member of the Optoelectronics group. He is working in the field of fiber optics sensors for applied spectrophotometry.

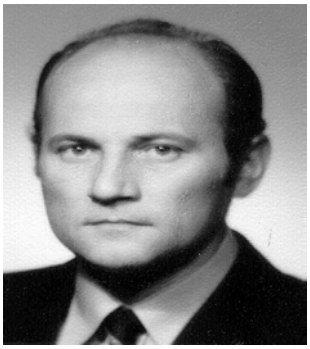


Jindřich Švorc was born in Praha in 1978. He graduated in Microelectronics from the FEE-CTU in Prague. He is a member of Microsystems group. He is currently working towards his PhD. His work is concentrated on simulation and optimization of microsensors and microsystems.

Telezhnikova Olga was born in 1977 in Kiev, Ukraine. She graduated in Microelectronics and Semiconductor Devices from National Technical University of Ukraine - "Kiev Polytechnic Institute". At present she is working towards her PhD. She is a member of the Optoelectronics group. Her work is concentrated on the fabrication and measurement of glass optical waveguides.

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.

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.



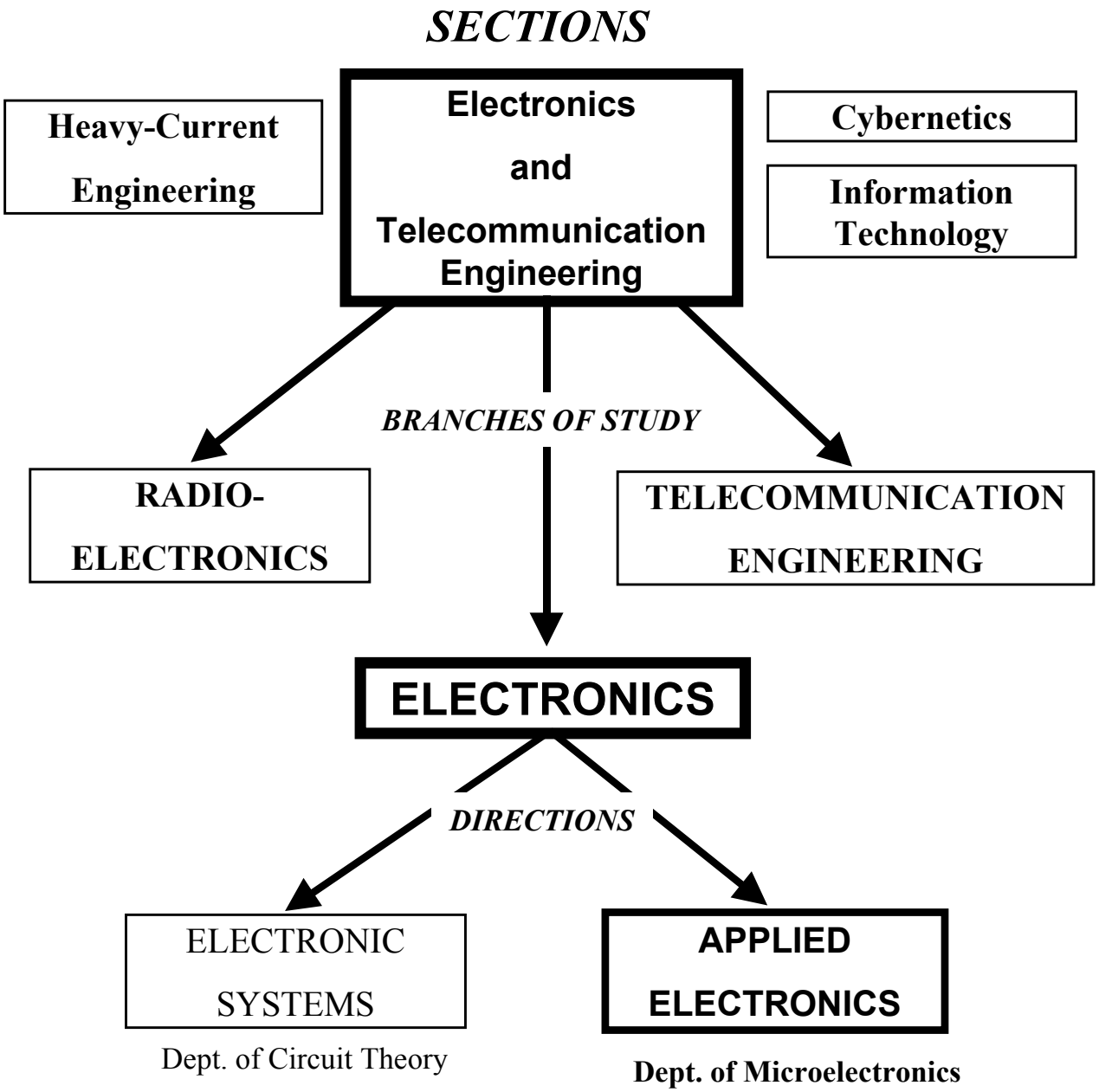
Lubomír Kafka was born in 1943. He attended the grammar school from 1958 to 1961. From 1961 to 1963 he studied the secondary school on "Mechanic of electronic equipments". In 1965 he joined the CTU in Prague as a technician. At present, he is working as a technician in the Department. He is responsible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

Vít Jeníček was born in 1978 in Prague. In 2002 he graduated in Material Engineering from the Faculty of Chemical Technology, Institute of Chemical Technology in Prague. At present, he is a member of technical service of the Department in the frame of the civil military service.

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, 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 specialisation emphasising the applications of electronics, electronic systems, optoelectronics and physical electronics.

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 endeavours 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 specialisation will find good jobs in industry of developed countries.

At present, a completely new curriculum comprising both the Bachelor and Master degrees is designed and acknowledged to come in effect in the year 2003.

CURRICULUM OF THE BRANCH ELECTRONICS

Obligatory and facultative subjects

(first two years of study):

Course name	Lectures and exercises in hours per week	Term
Obligatory subjects:		
Mathematics I	3 + 4	Winter
Introduction to Algebra	2 + 2	
Introd. to Computers Design and Programming I	3 + 2	
Physical Chemistry	2 + 1	
Introduction to Electrical Engineering	1 + 1	
Technical Documentation	2 + 2	Win/Sum
Economics	2 + 2	
Mathematics II	3 + 3	Summer
Mathematical Logic	2 + 1	
Introd. to Computers Design and Programming II	2 + 2	
Physics I	3 + 3	
Circuit Theory I	3 + 2	
Mathematics III	3 + 2	Winter
Physics II	4 + 3	
Circuit Theory II	3 + 2	
Material Technology for Electronics	2 + 1	
Electronics Microelectronics Dept.	2 + 2	
Electrical Measurements	3 + 3	
Mathematics IV	3 + 3	Summer
Electromagnetic Field Theory I	3 + 3	
Introduction to Computer Systems	2 + 2	
Facultative subjects:		
Basic Course on Power Electronics	3 + 2	Summer
Materials and Technology	3 + 2	

Obligatory and facultative subjects of the branch Electronics

Bachelor Study (beginning from the third year of a study (Microelectronics, Optoelectronics, Applied Electronics)

Course	Lectures and exercises in hours per week	Term
Obligatory subjects:		
Electron Devices Microelectronics Dept.	3 + 3	Winter
Electronic Circuits	4 + 2	
Mathematics V	2 + 2	
Electromagnetic Field and Waves	3 + 3	
Facultative subjects:		
Power Supply for Electronics Microel. Dept.	2 + 2	
CAD for High Frequency Techniques	2 + 2	
Analysis of Electronic Circuits	2 + 2	
Obligatory subjects:		
Basic Course on Digital Techniques	3 + 3	Summer
Linear Circuits and Systems	2 + 2	
Signals and Systems	4 + 2	
Facultative subjects:		
Microcomputers Microelectronics Dept. Circuit Tech. of Electronic Systems	2 + 2 2 + 2	
Antennas and Wave Propagation	2 + 2	
Obligatory subjects:		
Telecommunication Systems	3 + 3	Winter
Bachelor Project (only for st. ended as BSc.)	0 + 6	
Facultative subjects:	2 + 2	
Microelectronics Microelectronics Dept.	2 + 2	
Optoelectronics Microelectronics Dept.	2 + 2	
Sensor Systems Microelectronics Dept.	2 + 2	
Introd. to Digital Signal Processing	2 + 2	
Electrical Filters	2 + 2	
Application of Signal Processing for DSP	2 + 2	

MSc. COURSE
CURRICULUM OF THE BRANCH ELECTRONICS

Obligatory and facultative subjects (beginning from the fifth year of a study)

Course name		Lectures and exercises in hours per week	Term
Obligatory subjects:			
Mathematics VI		2 + 2	Winter
Digital signal processing		3 + 2	
Electronics of Semiconductors	Microelectron. Dept.	2 + 2	
Facultative subjects:			
Sensors in Security Systems	Microelectronics Dept.	2 + 2	
Design of Integrated Circuits	Microelectronics Dept.	2 + 2	
Architecture and Using of Programmable Circuits I		2 + 2	
Electronic Systems		2 + 2	
Obligatory subjects:			
Optoelectronics II	Microelectronics Dept.	3 + 2	Summer
Analogue and Digital Systems		3 + 2	
Semestral Project		0 + 4	
Facultative subjects:			
Practices on IC Design	Microelectronics Dept.	1 + 3	
Applications of Power Devices	Microelectronics Dept.	2 + 2	
Radiation Sources and Detectors		2 + 2	
Implementation of DSP		2 + 2	
Architecture and Using of Programmable Circuits II		2 + 2	
Obligatory subjects:			
Diploma Project	Microelectronics Dept.	0 +14	Winter
Practices in Laboratories of Electronics		0 + 4	
Facultative subjects:			
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

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		
Appliccation of Microelectronic Devices	2 + 2	Summer
Device Interconnection Techniques	3 + 1	S/W
PLD - Architecture and Application	2 + 2	Summer
Computer Interfaces	2 + 2	Summer

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
Diagnostics and Testing in Microelectronics
IC Design
Integrated Optics
Microsystems
Optical Radiation Detection and Detectors
Programmable Logic Devices
Prospective Electronic Devices
Semiconductor Radiation Sources
Technology of Optoelectronic Structures
VLSI Structures and Technologies

A BRIEF DESCRIPTION OF COURSES GIVEN BY THE DEPARTMENT

Electronics, (Basic course)

Semiconductors, PN junction, diodes, bipolar transistors, unipolar transistors, power amplifiers, small signal amplifiers, switching circuits. Power amplifier classes. Multilayer switching devices. Op-Amps. Optoelectronics: sources and detectors. Thermistor, posistor, Hall sensors. Power triode, klystron, magnetron, TWT. Applications.

Electron Devices, BSc

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.

Power Supplies in Electronics, BSc

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.

Application of Microelectronic Devices, BSc

Parasitic parameters of Op. Amps. Suppression of DC and AC residual errors in Op. Amps. Power amplifiers, stabilizers, switch mode power supplies. Logic circuit families. Interference: signal, supply, external, switching. Timing errors, data refresh, grounding. Integrated signal coders and decoders, telecommunications devices, AD and DA converters. Requirements, tolerances, application directions.

Microcomputers, BSc

Motorola 68HC05 and 68HC11 families. I/O tasks, MCS-48, 8243 expander, programmable peripheral ICs. Development and debugging tools. Design and programming of instruments and systems based on single-chip computers. Individual students' projects.

Computer Interfaces, BSc

Architecture of computers oriented mainly on IBM PC platform (Microprocessors in PC, available chip sets, trends, suppliers). Hardware and software description oriented on different kinds of interfaces. PC interface standards, throughput and data flow. Protocols, basic boards in PC. Floppy Disc, Hard Disc interfaces. Serial interfaces: RS232C, RS422A, RS485. Parallel interfaces: CENTRONICS, IEEE488. Computer networks. Internet, e-mail, conferences, WWW.

Microelectronics, BSc

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

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

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

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

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

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

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

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

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

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

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

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.

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

Principles of Technology CAD. ATHENA technology simulator. 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 ionisation and mobility. Heat flow equation. Boundary conditions. Boltzmann transport equation. Mathematical background of simulation techniques.

Device Interconnection Techniques

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

Programmable logic devices (PLD): history and perspectives, principles of operation, overview of basic architectures and production technologies. Simple PLD (PAL, GAL, PLA), Complex PLD (EPLD and CPLD), Field Programmable Gate Arrays (FPGA) : internal architecture, device types, properties, design principles and development systems. PLD design: design procedure, hardware description languages (ABEL, VHDL), partitioning, design implementation. Design economy, comparison with other ASIC methodologies. Design of SPLD and CPLD using various development systems (Lattice – Synario, Xilinx – Foundation).

TCAD for Electronics II, MSc

Technology CAD. Application of ATHENA technology simulator and ATLAS device simulator. Drift-diffusion and hydrodynamic models. Models of recombination, impact ionisation and mobility. Simulation of optoelectronic and power devices. Heat flow equation. Boundary conditions. Boltzmann transport equation. Monte Carlo Method. Simulation of quantum coupled devices. Simulation techniques. Examples.

Design of CMOS and BiCMOS Circuits, MSc

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.

Applications of TCAD Tools, PhD

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

Crystaloptics and Non-linear Optics, PhD

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.

Diagnostics and Testing in Microelectronics, PhD

Physical and electrical methods of measurement of material properties, operational structures and electronic devices. Test structures and test chips. Functional and parameter testing of integrated circuits.

Programmable IC Design, PhD

IC reasons of integration, IC design methodologies and approaches. Application Specific Integrated Circuits (ASIC) and programmable devices. Principles, architecture, technologies and internal structure of Programmable Logical Devices (PLD), Complex Programmable Logical Devices (CPLD) and Field Programmable Gate Arrays (FPGA). Automatic design tools. Design using Hardware Description Languages (HDL): Abel, VHDL. Design methodology, optimization and partitioning.

Integrated Optics, PhD

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, PhD

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, PhD

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, PhD

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, PhD

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, PhD

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, PhD

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, PhD

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

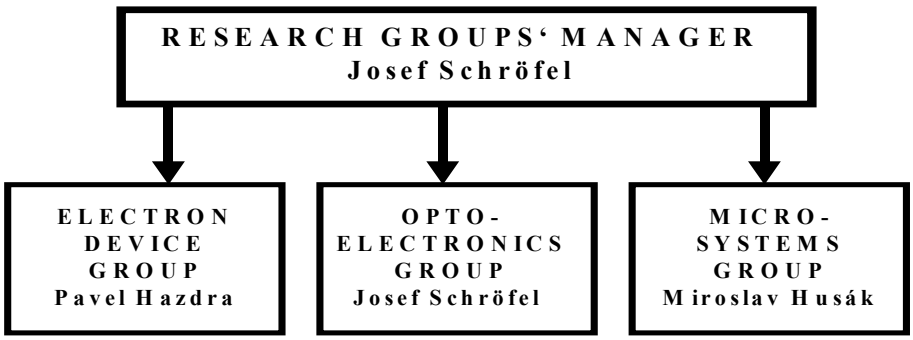
The Department has continued in research activities through grants and contracts from the Ministry of Education of the Czech Republic, Grant Agency of the Czech Republic, and CTU in Prague. A significant part of research activities was supported by the Programmes of the Ministry of Education in the following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

- Energy Quality and Savings,
- Environmental Research,
- Information and Communication Technology,
- Laser Systems and their Applications,
- New Measuring Methods of Physical Quantities,
- Reasoning and Control in Production,
- Trans-Disciplinary Biomedical Engineering Research.

The international projects were those of the NATO Science for Peace Programme and the 5th Framework Programme of the European Community, Access to Research Infrastructure Improving the Human Potential.

In the field of research contracts the co-operation has continued with Motorola Prague and East Kilbride.

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 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, R. Jackiv, D. Kolesnikov, V. Komarnickij, A. Mačkal, M. Sawalmeh.

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

OPTOELECTRONICS GROUP

Head of the research Group: J. Schrőfel

Members: Z. Burian, V. Prajzler, P. Čapek, V. Drahoš, J. Cakl, J. Zvěřina, O. Telezhnikova

Research Activities:

- Preparing and Testing of Planar Waveguides Based on Various Deposition and Diffusion Techniques
- Analysing, Preparing and Testing of Novel Planar Electro-Optic Structures for Distribution and Harnessing of Optical Radiation
- Research toward the Integrated Optic Circuits for Measuring 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, M. Seidenglanz, O. Starý, J. Švorc

Research Activities:

- Semiconductor Microsystem Structures
- Sensor Signals Processing and Wireless Transmission
- Sensor Control Systems
- Biomedical, Temperature, Pressure Sensors
- 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 decoration of radiation defects resulting from 10 MeV alpha particle irradiation by platinum diffusing from platinum silicide anode contact was used to locally decrease the carrier lifetime in 2.5 kV/100A diode. Comparison with He irradiated diodes with aluminum contacts showed lower leakage current and forward voltage drop in the PtSi diodes. The maximal reduction of the stored charge in the PtSi devices (up to 40 % of the untreated device) was found limited by the solid solubility of $Pt_s^{(-/0)}$ and the lower capture cross-section of platinum acceptor. The reduction corresponds to devices irradiated by He to the dose of $3x10^{10}$ cm^{-2}. Further means are investigated to increase the efficiency of lifetime reduction in devices diffused from anode PtSi layer.

GUIDED IN-DIFFUSION OF IMPLANTED PLATINUM IN SILICON POWER DIODES BY DEFECTS PRODUCED BY HELIUM CO-IMPLANTATION

P. Hazdra, J. Vobecký

Project support: European Community – Access to Research Infrastructure Action of the Improving Human Potential Program project HPRI-1999-00039 ref. 72, Grant no. 102/03/0456 -Grant Agency of the Czech Republic

The aim of the project is to find optimum conditions for guided in-diffusion of platinum into a low-doped n-type float zone silicon using radiation damage produced by helium co-implantation. A finite diffusion source of platinum was made by implantation of 1 MeV Pt ions at different doses ranging from 5×10^{11} to 5×10^{13} cm^{-2}. The co-implantation of 7 MeV He^{2+} was done with the dose of $1\times10^{12}cm^{-2}$ and subsequent diffusion was performed at different temperatures ranging from 650 to 750°C. The distribution of in-diffused platinum was studied by monitoring the acceptor level of substitutional platinum $Pt_s^{-/0}$ (E_C-E_T=0.23eV) by deep level transient spectroscopy. Results show that, similarly to guided in-diffusion from surface PtSi layer, the $Pt_s^{-/0}$ distribution follows well the profile of the damage produced by helium ions, but the amount of gettered

platinum is one order of magnitude lower and the diffusion temperature must be set to 725˚C to receive optimum results.

6.6 kV IGBT&FRD LIFETIME KILLING PROCESS

J. Vobecký, **P. Hazdra**, J. Rebollo*, X. Jorda*, P. Godignon*, M. Vellvehi*, L. Coulbeck**

***CNM Barcelona, Spain, ** Dynex, Semiconductor, U. K.**

Project support: European Community – Access to Research Infrastructure Action of the Improving Human Potential Program, Project No.HPRI-CT-1999-00107
Grant no. 102/03/0456 -Grant Agency of the Czech Republic

The aim of the project is the design of the optimal procedure for the local lifetime control of the IGBT and Fast Recovery Diode (FRD) chipset for high-power modules. A specific run of 6.5 kV vertical PT - IGBTs and FRDs was fabricated at Dynex Semiconductor. CTU in Prague performed the simulation works necessary for design of the irradiation procedure, namely the helium, combined electron-helium, and combined platinum-helium implantation with subsequent annealing. The processed wafers were implanted in accelerator facilities in Forschungszentrum Rossendorf, Germany. Power modules (4 IGBTS and 2 FRDS in parallel) were assembled and characterized in Dynex Semiconductor.

CHARACTERIZATION OF RADIATION DEFECT PROFILES FOR ACCURATE SIMULATION OF POWER DEVICES IRRADIATED WITH PROTONS, ALPHAS AND LOW-ENERGY ELECTRONS

P. Hazdra, V. V. Komarnickij, J. Vobecký

Project support: European Community – Access to Research Infrastructure Action of the Improving Human Potential Program Project HPRI-1999-00039, Ref. 72

The project deals with detail characterization of defect profiles produced in float-zone silicon by irradiation with MeV protons, alphas and 500 keV electrons to accurately simulate influence of irradiation on power device characteristics. Radiation defect profiles were investigated in the low-doped <100>-oriented FZ n-type silicon substrate forming the n-base of the planar p^+nn^+ diodes. The diodes were irradiated with 1.8, 2.8, 3.6 and 7.35 MeV protons and 8, 12 and 14.5 MeV alphas at fluences ranging from 1×10^9 to 1×10^{11} cm^{-2} using the 5 MeV Tandem accelerator in FZ Rossendorf. The irradiation with 500 keV electrons at fluences from 2×10^{13} to 1×10^{15} cm^- was

performed at ELV-2 accelerator in IPF Dresden. The irradiation covered nearly all projectiles and energies of practical use which are giving inhomogeneous defect distribution. Profiles of electron traps were measured by recently introduced High Voltage Current Transient Spectroscopy (HVCTS) and I-V profiling in combination with capacitance DLTS and C-V measurement. Full depth profiles of dominant recombination centers (divacancies and VO pairs) were established and compared with the simulated distributions of primary damage (vacancies) received by Monte Carlo simulation code SRIM-200.40. For all projectiles, deviations between the simulated and measured profile were discovered. Introduction rates of particular defects in different parts of the profile, i.e. at the defect maximum (peak) and the surface region (tail), were also established for all irradiation energies. This allowed us to calibrate accurately defect introduction into power devices by their irradiation and include it into contemporary TCAD device simulators to improve their prediction capability.

PLATINUM SILICIDE CONTACTS FOR HIGH-POWER DEVICES

J. Vobecký, **D. Kolesnikov, P. Hazdra**

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

PtSi contact as a new contact material for high-power P-i-N diode is shown to markedly decrease the contact resistance and total device forward voltage drop. The thickness of the sputtered Pt layer (50, 100, 200nm) and sintering time (20, 40, 60, 80 min.) was varied to find the minimal contact resistance. The application of the novel PtSi contact is carried out on the 2.5 kV/100A diode in comparison with that of standard Aluminum to find a way towards reliable very low-resistance contacts. The parameters of devices with contact stacks formed by PtSi-TiW-AlCuSi, PtSi-AlCuSi, and PtSi-Al were compared with those of Ti-Ni-Ag and Al.

RADIATIVE RECOMBINATION MECHANISM OF SUBNANOMETRIC InAs/GaAs LASER STRUCTURES

P. Hazdra , J. Voves , E. Hulicius*, J. Pangrác* and J. Oswald*
*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

The main goal of this grant project is to identify and explain the strong interaction between δ-layers in the multiple structure, which is responsible for the energy shift and enhanced optical quantum efficiency, and support this

investigation with adequate theoretical models which will be used for explanation of photoluminescence (PL), electroluminescence (EL), and photocurrent (PC) measurements on the InAs δ-layers in GaAs grown by MOVPE. The next aim is to further optimize the multi δ-layer structure and use it as an active layer for preparation of low-threshold semiconductor lasers operating in the wide spectral (850-1300 nm) and temperature (above 100 ^{o}C) range.

In the first year of the project, we focused on the MOVPE growth of single InAs δ-layers with different thickness W_L, double δ-layers separated by the GaAs spacer with a variable thickness S_L and different multiple δ-quantum well structures suitable for active layers of semiconductor lasers. While, in the first two cases, the calibration of the theoretical model and of the MOVPE growth was of the primary importance, the growth of multiple δ-quantum wells was focused on shift of emission wavelengths to lower energies. All δ-layer structures were grown in the AIXTRON 200 MOVPE horizontal low pressure reactor in the Institute of Physics ASCR. Samples were structurally characterized by the Transmission Electron Microscopy (TEM), the Scanning Tunnelling Microscopy (STM) and the X-ray diffraction (XRD). Optical properties were measured by PL and PC spectroscopies at the Department of Microelectronics CTU Prague. Results of the structural characterization with atomic resolution show that MOVPE is capable to growth very thin δ-layers (up to one monolayer) without significant broadening given by indium diffusion. The distance and thickness of δ-layer can be accurately controlled by growth parameters. We also found a good qualitative and quantitative agreement between our theoretical model and measured PC and PL data for single and double δ-layers when we used W_L and S_L magnitudes from STM and XRD analysis.

DESIGN, SIMULATION AND CHARACTERISATION OF MBE GROWN SEMICONDUCTOR STRUCTURES

J. Voves, P. Hazdra, I. Hoffmann[**], M. Cukr[*], Z. Výborný[*], **T. Třebický**
[*]Inst. of Physics, Academy of Sciences, Czech Republic
[**]Department of Electromagnetic Field, FEE CTU Prague

Quantum electronic devices based on GaAs/GaAlAs heterostructures suitable for electronic applications and education purposes (RTD, HEMT, superlattices) 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, as well. A new model based on the transfer matrix method has been developed. 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 has been designed. and characterised. High frequency analysis of these devices has been performed as well.

OPTOELECTRONICS GROUP

OPTICAL WAVEGUIDE STRUCTURES BASED ON ION - EXCHANGE IN GLASS SUBSTRATES

J. Schröfel, J. Špirková*, J. Čtyroký**, L. Salavcová*, P. Třešňáková*, J. Denk*, **V. Drahoš, K. Bušek**
* Dept. of Inorganic Chemistry, ICT.
** 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.

Planar and channel waveguide structures fabricated by ion-exchange in glass could be potentially utilised in large variety of components for distribution and harnessing of optical radiation. The research work deals with study of preparation and properties of single-mode and multi-mode planar waveguides based on pure thermal or field-assisted exchange of $K^+ \leftrightarrow Na^+$, $Li^+ \leftrightarrow Na^+$ and $Cu^+ \leftrightarrow Na^+$ ions. The research has continued in fabrication of single mode channel waveguides and verification of their application in distributive and sensor structures.

OPTICAL WAVEGUIDE STRUCTURES BASED ON APE IN $LiNbO_3$

J. Schröfel, J. Špirková*, J. Čtyroký**, L. Salavcová* **, Z. Burian,** P. Čapek**,** P. Třešňáková*, **V. Drahoš, J. Zvěřina, J. Cakl**
*Dept. of Inorganic Chemistry, ICT.
**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.

Annealed proton exchange (APE) provides a perspective alternative for fabrication of high quality single mode and multi-mode channel waveguides in lithium niobate. The last experimental works are concerned on explanation of the relations between lithium and hydrogen subsurface distribution and refractive index profile and properties of the waveguides. The research has continued in verification of possible application of prepared waveguides in optical modulators, sensors and the perspective active waveguides.

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

J. Schröfel, J. Špirková*, P. Čapek, **Z. Burian**, J. Čtyroký**, M. Slunéčko, L. Salavcová*, P. Třešňáková*, **V. Drahoš**, V. Jeřábek, **J. Zvěřina, J. Cakl**
* Dept. of Inorganic Chemistry, ICT.
** 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 continue in fabrication of waveguides in erbium-doped substrates. The very important task of the research is study the relationship between the properties of the substrates, technological conditions waveguides fabrication and properties of the fabricated waveguides. The absorption and luminescence properties of the erbium doped channel waveguides are characterised and the optical gain is measured.

ERBIUM DOPED OPTICAL WAVEGUIDES ON CARBON AND CARBON NITRIDE BASE

J. Schröfel, Z. Burian, *I. Hüttel*, J. Čtyroký**,* ***V. Prajzler, A. Drahoš***
* Department of Solid-State Engineering, ICT, Prague.
** Inst. of Radio Eng. and Electronics, Academy of Sciences, CR.
Project support: Grant Agency of the Czech Republic, No.102/00/0895.

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 layer of silicon oxide providing optical shielding of the substrate and is prepared by the oxidation of silicon wafer. The present works are concentrated on determining of suitable conditions of technological process and on measuring 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 the active waveguides as well.

ERBIUM DOPED GALLIUM NITRIDE PLANAR WAVEGUIDES

J. Schröfel, Z. Burian, I. Hüttel*, J.Stejskal*, J. Čtyroký**, **V. Prajzler**
* Department of Solid-State Engineering, ICT.
** Inst. of Radio Eng. and Electronics, Academy of Sciences of the Czech Republic.

The aim of the project is to fabricate and investigate gallium nitride optical planar waveguides. Main methods of fabrication of the gallium nitride layers are Metal Organic Chemical Vapor Deposition and magnetron sputtering. Very important task of the research is erbium doping gallium nitride layers. Optical materials doped by erbium ions can by used for fabrication optical amplifiers or lasers.

DESIGN OF FIBRE SENSOR WITH LIQUID CORE FOR CHEMICAL TRACE ANALYSIS

Z. Burian, P. Solařík
Project support: CTU Research Programme DN MSM 212300016

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 to extend 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 modelled, simulated and the most suitable technology and materials were searched for.

MICROSYSTEMS GROUP

POWER SUPPLY FOR MICROSYSTEMS

M. Husák, V. Janíček
Project support: Grant Agency of the Czech Republic, No.102/00/0939

This project solves the problem of power supplies for implanted microsystems without a physical contact to outer world. Today, there are two modules solutions consisting of microsystem with sensor and the external power supply block. Today's common solutions of power supplies are very voluminous and can't be implanted with the microsystem. Therefore, there is an idea to integrate the power supply into a microsystem. The main principle of power generation is a piezoelectric effect in PZT ceramics and PVDF polymer materials. There are in principle two attractive approaches of energy storage, namely the

rechargeable batteries and super capacitors. The aim is to propose a self-powered microsystem, like a pacemaker.

ELECTROMAGNETIC COMPATIBILITY IN MICROSYSTEM DESIGN

J. Novák, J. Foit

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

The aim of the project is EMC solution in the systems of considerably smaller dimensions, first of all inside the encapsulations of miniaturized systems as integrated circuits, microsensors and the like. The theoretical works for simulations of parasitic couplings in such systems, especially regarding the differences macroscopic cases, are close to finish. The work planned for the next year or so will be devoted to experimental verifications of the theoretical results, provided that the necessary instrumentation can be secured.

ELECTRO-THERMAL SIMULATION OF GaAs POWER SENSOR MICROSYSTEM

J. Jakovenko, M. Husák

Project support: NATO SfP Project No.: SfP-974172

In this work we report on the thermo-mechanical simulations performed in the aim of optimising the temperature distribution of microwave power sensor microsystem. By means of thermal simulations we propose a GaAs cantilever beam design and layout of the HFET heater and temperature sensor placed on micro machined cantilever beam. Spatial temperature dependences, thermal time constant and power-temperature dependencies at different ambient atmospheres are calculated from the heat distribution. The 3D thermal and thermo-mechanical simulations of the sensor structures are performed using Memcad and CowentorWare from Microcosm Technologies.

INTELLIGENT INTEGRATED MICROSENSOR FOR UV RADIATION FOR BIOMICROSYSTEM

L. Jirásek

Project support: Grant Agency of the Czech Republic, No. 102/03/0619
CTU Research Programme JD MSM 210000012

Development of UV radiation microsensor suitable for integration into biomicrosystem 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).

MICROSTRUCTURES FOR ELECTROACOUSTIC APPLICATIONS

M. Husák, M. Seidenglanz

Project support: Ministry of Education, Youth and Sports of Czech Republic – project Barrande No. 2003-034-2

The aim of the project is design front-end and biasing circuits for Silicon Capacitive Microphones (SCM). In the year 2003, the design and realization of high input impedance, low-noise, wide-band preamplifier from discrete components were finished. This preamplifier will be use for testing and measurement already realized SCM. Further work will be aim to design of preamplifier suitable for integration together with capacitive sensor structure in CMOS technology. Primary study advert to utilize of Transconductance Amplifiers (OTA), switched capacitor technique or ΔΣ analog-to-digital converter. Biasing Circuits are based on DC-DC charge pumps, for example Dickson charge pumps.

STRAIN GAUGE SENSORS FOR HIGH-TEMPERATURE APPLICATIONS

P. Kulha, M. Husák

Project support: Grant Agency of the Czech Republic, No. 102/03/0619
Project support: Grant CTU 0307513

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. It is assumed that the sensor will be used for 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.

TEMPERATURE SENSITIVE MICROSTRUCTURES

Project support: Grant Agency of the Czech Republic, No. 102/03/H105

O. Starý, M. Husák

This project solves the problems how to design the temperature sensors and required analog interface electronics on a single silicon chip and how to make properly working A/D converter in wide temperature range. The general goal of this project is to develop the thermal flow sensor on single chip. This kind of anemometer measures except the velocity the direction of the flow as well. This design also includes the task how to heat the silicon chip. The thermal simulations of the temperature distribution on the chip, depending on the flow, will be performed by Memcad and CowentorWare from Microcosm Technologies. Simulations of the electronic circuits are performed using Cadence.

RESEARCH GRANTS AND CONTRACTS

Accurate Control of Recombination Centre Introduction in Silicon
European Community – Access to Research Infrastructure Action of the Improving Human Potential Program, Project No. HPRI-1999-00039, Ref. 72
Project Manager: **P. Hazdra**

Radiative Recombination Mechanism of Subnanometric InAs/GaAs Laser Structures
The Grant Agency of the Academy of Sciences, CR, No. IAA1010318
Project Manager: **P. Hazdra**

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

Microwave Monolithic Integrated Transmitted Power Sensors and Their Industrial and Metrology Applications.
Grant EU NATO Science for Peace Programme, no. SfP-974172
Project Manager: T. Lalinský (Slovak Academy of Science, Institute of Electrical Engineering, Bratislava, (Dept. of Microelectronics: **M. Husák)**

Trans-Disciplinary Biomedical Engineering Research.
Research Programme no. JD MSM 210000012
Project Manager: Konvičková (Faculty of Mechanical Engineering, CTU)
(Dept. of Microelectronics: **M. Husák**)

Research of New Methods for Physical Quantities Measurement and Their Application in Instrumentation.
Research Programme no. JB MSM 210000015
Project Manager: V. Haasz (Faculty of Electrical Engineering CTU in Prague)
(Dept. of Microelectronics: **M. Husák**)

Formation and Monitoring of Environment
Research Programme no. DN MSM 212300016
Project Manager: R. Bálek (Faculty of Electrical Engineering CTU in Prague)
(Dept. of Microelectronics: **M. Husák**)

Reasoning and Control in Production
Research Programme no. JD MSM 212300013
Project Manager: V. Mařík (Faculty of Electrical Engineering CTU in Prague)
(Dept. of Microelectronics: **Z. Rozehnal**)

Information Technologies, Research Project of the Ministry of Education
Research Programme no. JW MSM 213200014
Project manager: J. Vejražka (Dept. of Radioelectronics, FEE-CTU)
(Dept. of Microelectronics: **J. Schrőfel**)

Laser Systems and Their Applications
Research Programme no. JA MSM 210000022
Project manager: J. Vrbová (Faculty of Nuclear Science, CTU in Prague)
(Dept. of Microelectronics: **J. Schrőfel**)

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

The study of optical induced diffusion and melting the silver in thin amorphous chalcogenide layers prepared by spin coating methods and their applications
Grant Agency of Czech Republic, Project no.203/02/0087
Project Manager: **J. Schrőfel**

6.6 kV IGBT&FRD Lifetime Killing Process
European Community – Access to Research Infrastructure Action of the Improving Human Potential, Project No.HPRI-CT-1999-00107, MicroServ (2002 - 3)
Project Manager: **J. Vobecký**

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

Energy Quality and Energy Savings
Research Programme no. JE MSM 212300017
Project Manager: J. Tůma (Dept. of Electronergetics, FEE-CTU)
(Dept. of Microelectronics: **J. Vobecký**)

Current Injection Capability Investigation of Microcontroller Units
MOTOROLA, Munich, East Kilbride
Project Manager: **J. Vobecký**

The Simulation of Silicon Radiation Detector
TESLA Sezam, a. s., Rožnov pod Radhoštěm
Project Manager: **J. Voves**

DC and HF Chracterisation of MBE Grown HEMT and RTD Structures
Institute of Physics, Academy of Sciences, Czech Republic
Project Manager: **J. Voves**

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SOCRATES Programme 1999/2000, 2000/2001, 2001/2002.
(Dept. of Microelectronics: **M. Husák**)

- Foreign Training in the Area of Electronic System Design

LEONARDO DA VINCI Programme 2001- 2003
(Dept. of Microelectronics: **M. Husák**)

- Microsensors and Microsystems in Bachaleor study.

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