ANNUAL REPORT

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

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Edited by Jan Vobecký (January 2005)

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 27 years more than 1000 students graduated in the branch of Microelectronics and 35 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 Framework Programmes of the European Community.

The Department gives a high priority to collaborative research with industry. In 2004 year, co-operation contracts were signed with MOTOROLA, Freescale Semiconductors, and ON-Semiconductor. Donation from Cadence was accepted to continue the education of IC design at the level complying with current requirements of contemporary practice.

This brochure is the 15th 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 2005

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.
	J. Foit, M.Sc., Ph.D.

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., Ph.D.
	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., PhD.(2004)
	J. Bláha, MSc.
	A. Bouřa, M.Sc.
	K. Bušek, MSc.
	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. Seidenglanz, M.Sc.
	P. Solařík, M.Sc.

Ph.D. students (cntd.): O. Starý, M.Sc.
P. Suchánek, MSc.
J. Švorc, M.Sc.
O. Telezhnikova, M.Sc.
T. Třebický, MSc.

SUPPORT STAFF

Administration

R. Burianová
H. Kubátová

Teaching Laboratories:

L. Kafka

Technical Service: M. Horník

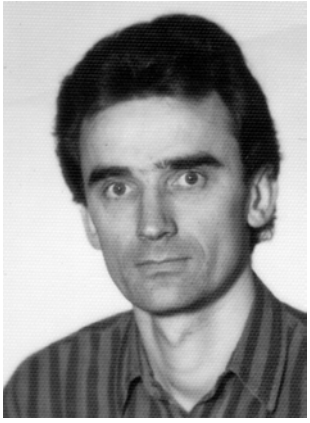
Military Service (duty to compensate):

V. Jeníček

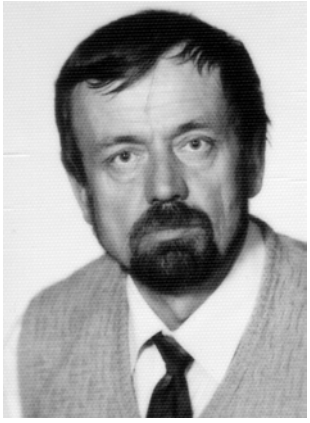
ABOUT THE STAFF

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).

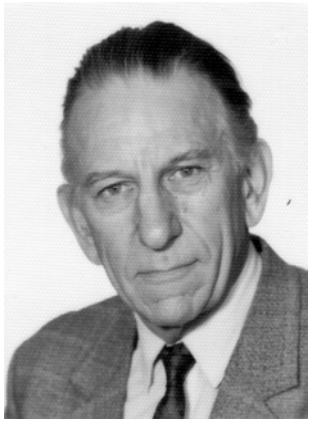
Jiří Kodeš was born in 1932. He received MSc., Ph.D., and D.Sc. degrees in electronics, semiconductor physics and microelectronics from the CTU in Prague in 1956, 1963 and 1990, resp. At present, he is Full Professor at the Department. His area of research includes electronic transport in semiconductors 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 - 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.



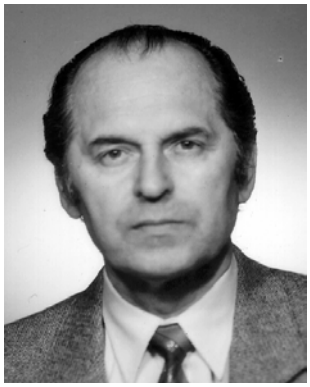
Julius Foit was born in 1932. He received MSc., PhD. and Ass. Prof. degrees in Radar Engineering, Colour TV Eng. and Multiphase Signal Processing from the CTU in Prague in 1954, 1961 and 1978, resp.. Dean of the Faculty in the University of Maiduguri, Nigeria in 1987-1989 and B. Tech. Programme Coordinator 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 130 scientific and technical papers, 2 patents and printed lectures. SM IEEE. Chairman of the MTT/AP/ED Chapter - Czechoslovakia Section IEEE.

Josef Schrőfel born in 1933. MSc. from FEE-CTU in Prague, 1956. PhD. from STU Bratislava in 1972, DrSc. from FEE-CTU in Prague in 1994, Assoc. Professor 1996. In 1974-90 he was with Tesla Research Inst., Prague, researching electronic components, thin-films, solid state surface phenomena and semiconductors. Since 1975 his field is optoelectronics, optical fibres and integrated optics. Author of about 120 papers, 17 patents, 2 monographs and 3 books. Member of IEEE and EOS.
He has died on 15th March 2004 after a serious disease.

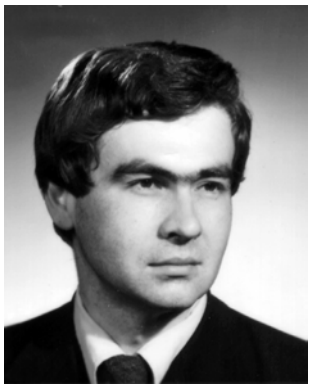
Miroslava Šemberová was born in 1939. She graduated in Radioelectronics from the FEE-CTU in Prague, in 1961. She received PhD. degree in 1973 and Associate Professorship in 1985. She is author of 12 technical papers and 10 printed lectures. She gave lectures in the area of electronic and microelectronic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



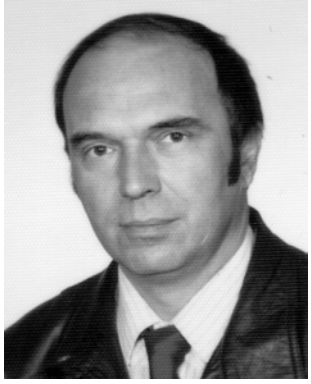
František Vaníček was born in 1936. He graduated in Radioelectronics from the FEE-CTU in Prague, in 1960. PhD. in 1972 and Assoc. Professorship in 1978. From 1972 to 1975 he gave lectures in MTC Kahira, Egypt, and from 1981 to 1983 in HIE Beni Walid, Lybia. He is the author of 15 techn. papers and 10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

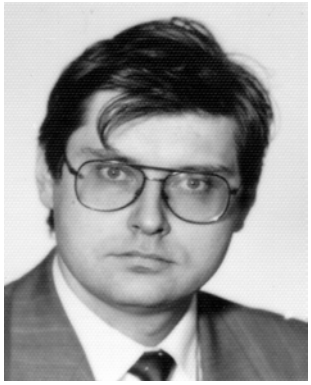


Lubor Jirásek was born in Prague in 1953. He graduated from the FEE CTU in Prague, in 1978. He received PhD. degree in Electronics in 1983. From 1978 to 1983 he was working as a Research Fellow in the area of high-power devices. He is author of 7 technical papers and 3 printed lectures. He is teaching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

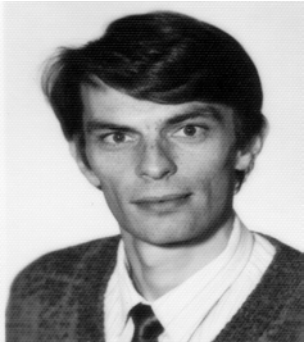
Jiří Jakovenko born 1972, Prague. He graduated in Microelectronics from FEE-CTU, Ph.D. degree from FEE-CTU in 2004. Member of Microsystems group. Research: MEMS design and modeling. In 1998 he spent 4 months in Hogeschool Gent in the frame of TEMPUS programme. Author of many scientific and technical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



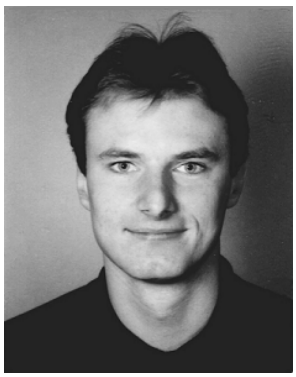
Alexandr Krejčiřík was born in 1947. He graduated in Electrotechnology from the Faculty of Electrical Engineering, CTU in Prague, in 1971. He received PhD. degree in Mathematics and Physics – branch Semiconductors. He is the author of 10 technical papers, 21 printed lectures and 12 textbooks. He is teaching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



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.



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.

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.

Pavel Čapek was born in Prague in 1977. He graduated in Microelectronics from the FEE-CTU in Prague in 2001. In 2004, he finished his Ph.D. in the field of active integrated optical waveguides. He is the author of several scientific papers. He is member of the Optoelectronics group.

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.

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. He is a member of the Microsystems group. His work is focused on wireless sensor systems.

Karel Bušek was born in Zliv in 1976. He graduated in Microelectronics from the FEE-CTU in Prague in 2004. Since 2004 he is a PhD student at the Department of Microelectronic. He is a member of the Microsystems group. His work is focused on opto-chemical sensors.

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. 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, contact properties and passivation of junction termination.

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 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.

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 he was a 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.

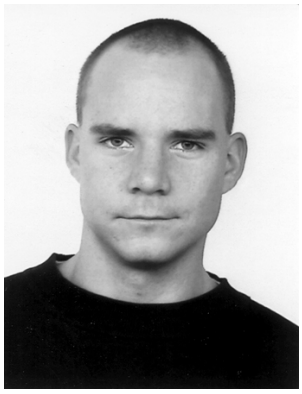
Václav Prajzler was born in Prague in 1976. He graduated in Microelectronics from the FEE-CTU in Prague, in 2001. He is working towards his Ph.D. He is member of the Optoelectronics group. His work is concentrated on the fabrication and diagnostics of optical passive and active planar waveguides.

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.

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 design of electronic devices for polymer electronics.



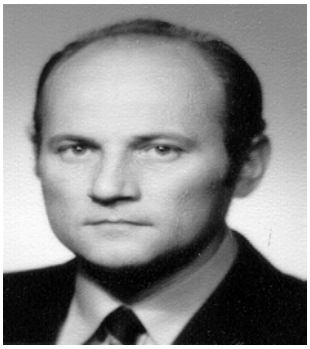
Jindřich Švorc was born in Prague in 1978. He graduated in Microelectronics from the FEE-CTU in Prague. He is a member of Microsystems group. He is currently working towards his PhD. His work is concentrated on simulation and optimization of microsensors and microsystems.

Olga Telezhnikova 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.

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.

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. At present, she is the Secretary of the Head of the Department.



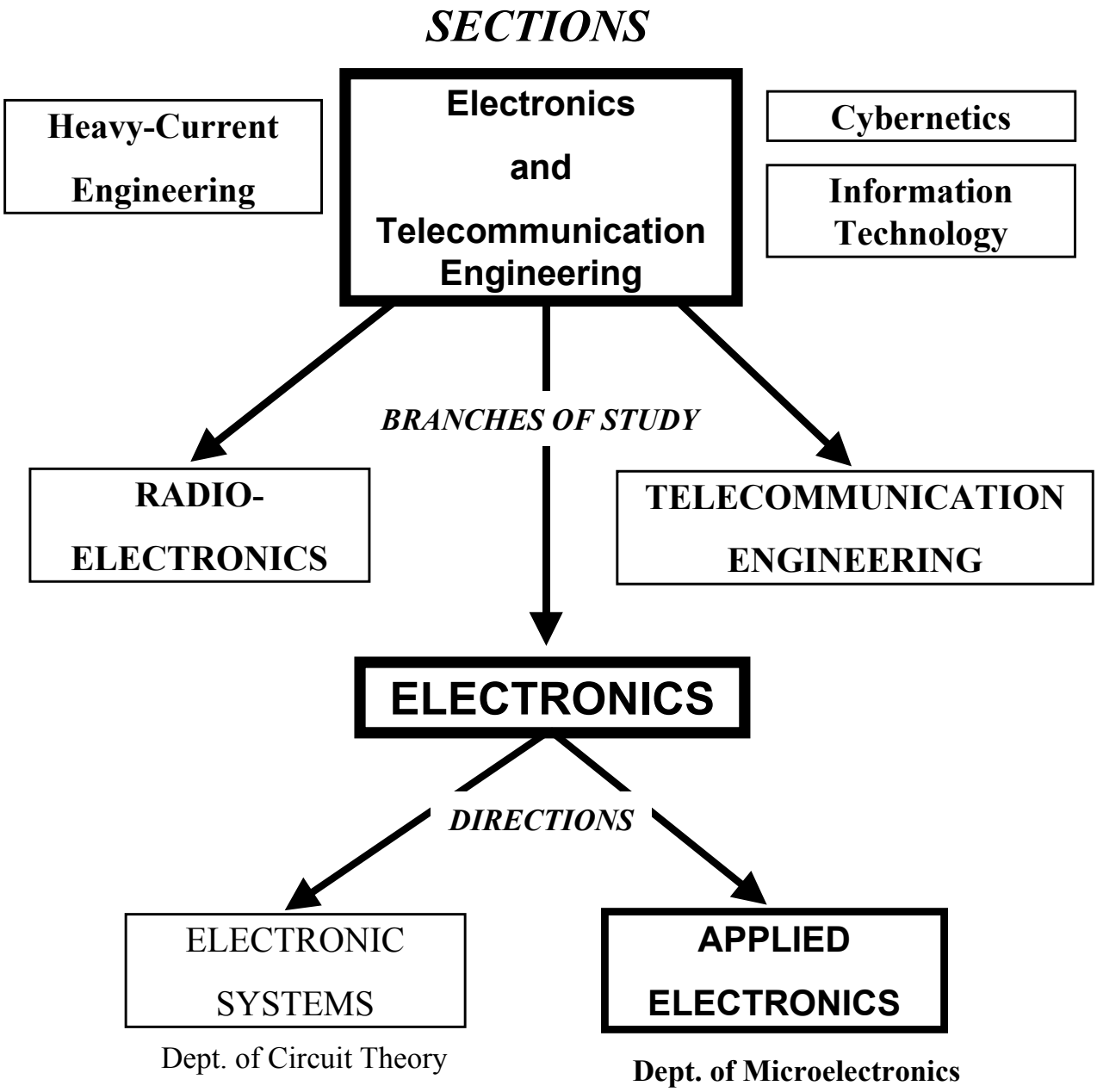
Lubomír Kafka was born in 1943. He attended the grammar school from 1958 to 1961. From 1961 to 1963 he studied the secondary school on "Mechanic of electronic equipments". In 1965 he joined the CTU in Prague as a technician. At present, he is working as a technician in the Department. He is responsible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

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 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 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 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 phase after passing examination.

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	
Algortihms	2 + 2	
Electrical Circuits I	2 + 1	
Sports	0 + 2	
Technical Documentation	2 + 2	Win/Sum 1st year
Economics	2 + 2	
Mathematics II	2 + 2	Summer / 1st year
Electrical Circuits II	2 + 2	
Electronics	2 + 2	
Physics I	3 + 2	
Sports	0 + 2	
Obligatory subjects to choose:		Winter / Summer 1st year
English language	0 + 2	
French language	0 + 2	
German language	0 + 2	
Russian language	0 + 2	
Spanish language	0 + 2	
Czech language (for foreign students)	0 + 2	
Facultative subjects:		
Seminar on Electro-technique	0 + 2	
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	
Enterprise 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	
Sports	0 + 2	
Electromagnetic Field Theory	2 + 2	Win/Sum 2nd year
Economics for enterprises	2 + 1	
Introduction to Digital Technique	2 + 2	Summer / 2nd year
Electron Devices	2 + 2	
Signals and Systems	3 + 1	
Sports	0 + 2	
Obligatory subjects to choose:		
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	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 Waveguides	2 + 2	Winter / 3rd year
Electronic Circuits for Communication	2 + 2	
Management of Communication Technique	2 + 2	
Project	2 + 2	
Humanities	2 + 0 or 0 + 2	
Communication Systems and Networks	2 + 2	Summer / 3rd year
Photonics	2 + 2	
Communication Technique – Radio Systems	2 + 2	
Basic Measurements in Communications	1 + 2	
Humanities	2 + 0 or 0 + 2	
Bachelor Project	0 + 5	
Obligatory subjects to choose:		Winter / Summer 3rd year
Mathematics 3B	2 + 2	
Design and Technology	2 + 2	
Mathematics 4B	2 + 2	
Sensors in Electronics	2 + 2	
Multimedia and TV	2 + 2	
Antennas and Propagation – Basic Course	2 + 2	
Power Engineering - Basic Course	2 + 2	

Obligatory and facultative subjects of the branch Electronics – old curriculum

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:		Winter
Electron Devices Microelectronics Dept.	3 + 3	
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:		Summer
Basic Course on Digital Techniques	3 + 3	
Linear Circuits and Systems	2 + 2	
Signals and Systems	4 + 2	
Facultative subjects:		
Microcomputers Microelectronics Dept.	2 + 2	
Circuit Tech. of Electronic Systems	2 + 2	
Antennas and Wave Propagation	2 + 2	
Obligatory subjects:		Winter
Telecommunication Systems	3 + 3	
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 – old curriculum
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:		Winter
Mathematics VI	2 + 2	
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 D	2 + 2	
Architecture and Using of Programmable Circuits I	2 + 2	
Electronic Systems	2 + 2	
Obligatory subjects:		Summer
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 Microelectronics	2 + 2	
Radiation Sources and Detectors	2 + 2	
Implementation of DSP	2 + 2	
Architecture and Using of Programmable Circuits II	2 + 2	
Obligatory subjects:		Winter
Diploma Project Microelectronics Dept.	0 +14	
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 – old 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		
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, BSc

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

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.

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 – Silvaco tools. 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. The practice of device simulation: diode, BJT, MOSFET.

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): 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

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

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

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

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

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

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

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

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

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

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

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

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

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

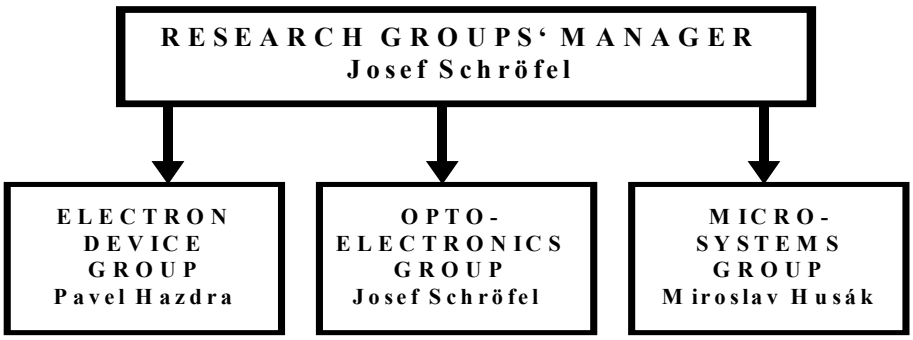
The Department has continued in research activities through grants and contracts from the Ministry of Education of the Czech Republic, Grant Agency of the Czech Republic, and CTU in Prague. A significant part of research activities was supported by the Programmes of the Ministry of Education in the following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

- 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 Framework Programmes of the European Community.

In the field of research contracts the co-operation has continued with Motorola and Freescale Semiconductors, Prague, Munich, 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 organisation 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, A. Mačkal, 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: J. Schrofel† (1 – 3/2004), Z. Burian (3 – 12/2004)

Members: Z. Burian, V. Jeřábek, V. Prajzler, P. Čapek, K. Bušek, V. Drahoš

Research Activities:

- Preparation and Testing of Planar Waveguides Based on Various Deposition and Diffusion Techniques
- 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 Optical 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, M. Seidenglanz, O. Starý, J. Švorc, A. Bouřa, Z. Otčenášek, P. Suchánek

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 high energy alpha particle irradiation by substitutional platinum was used to locally decrease the carrier lifetime in 2.5 kV/100A diode. Two different processing methods were compared. Firstly, the diffusion from platinum silicide anode contact, i. e. from infinite source. Secondly, the diffusion from implanted layer of platinum (1 MeV, $5\times10^{11}\div 5\times10^{13}$ cm^{-2}), i. e. from finite source. The latter was found to strongly depend on the quality of surface and defects inside the device. Further provisions are being looked for to increase the efficiency of the lifetime reduction using the implanted platinum. The motivation arises from the fact that the implantation gives good control of the process compared to that of PtSi – for more details see the project below.

RADIATION ENHANCED DIFFUSION OF IMPLANTED PLATINUM IN SILICON GUIDED BY HELIUM CO-IMPLANTATION FOR ARBITRARY CONTROL OF PLATINUM PROFILE

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 exploit platinum atoms – the ideal center for carrier recombination – for local lifetime killing in silicon. In this stage of the project, the in-diffusion of platinum into low-doped n-type float zone silicon guided and enhanced by radiation damage produced by co-implantation of helium ions was investigated. The implantation of 1 MeV platinum ions at different doses ranging from 5×10^{11} to 5×10^{12} cm^{-2} was used to produce a finite source for platinum diffusion. Single and multiple energy implantation of helium ions with energies 7, 9, 11 and 13 MeV introducing different profiles of radiation defects were applied to enhance and shape the diffusion of platinum atoms performed by 20 minutes annealing at 725°C in vacuum. 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 the helium co-implantation significantly enhances platinum diffusion and allows its control up to the depths of hundreds of micrometers. The resulting Pt_s distribution is given by the profile of radiation damage produced by helium ions while the amount of in-diffused Pt_s can be controlled by the dose of platinum implantation. It is also shown that an extra annealing at 675°C performed prior to helium implantation substantially increases the amount of in-diffused platinum

ADVANCED LIFETIME KILLING IN SILICON POWER DEVICES BY HIGH ENERGY PARTICLE IRRADIATION

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, Grant no. 102/03/0456 -Grant Agency of the Czech Republic

The aim of the project develop novel method for optimization of silicon power device parameters using lifetime killing techniques based on high energy particle irradiation. We investigated the effect of sloping lifetime reduction in the power chip P-i-N diode using 500 keV electron and high energy proton irradiation and compared it with local lifetime killing by high energy alphas. The device under test was a planar 100A/1200V P-i-N chip diode produced on the low-doped <100>-oriented FZ *n*-type silicon substrate. The reference local lifetime reduction was done by irradiation with alphas at fluences ranging from 2×10^{10} to 2×10^{11} cm^{-2}. The alpha's range was set into three qualitatively different regions (anode emitter, anode space charge region and *n*-base space charge region) covering the most important locations from the point of application. Irradiation with low-energy (500 keV) electrons was used to produce the gradual sloping profile. The sharp sloping profile was introduced by a high-energy (7.35 MeV) proton irradiation with fluences from 1.4×10^{10} to 2×10^{12} cm^{-2}. Different sets of aluminum foils were placed in the front side of irradiated diodes. This allowed us to place the back side of the wide Gaussian radiation defect peak produced by high energy protons to desired locations in the diode (comparable to those irradiated by alphas). Defects produced by irradiation were characterized by capacitance deep level transient spectroscopy, high-voltage current transient spectroscopy, I-V and C-V profiling. Static and dynamic parameters of modified diodes were recorded and compared to those measured before irradiation.

Results show, that the gradually decreasing profile of recombination centers produced by low-energy electrons cannot substitute for local lifetime reduction

in diodes with base thicknesses below 500μm. The sloping lifetime control by defects produced in the end-of-range region of high energy protons provides identical trade-off between the ON-state and turn-off loses as a traditional local lifetime killing by alpha-particles. However, it provides lower increase of leakage compared to the local lifetime reduction by alphas, if we compare irradiations leading to the equivalent reduction of turn-off losses.

PtSi AND 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

PtSi contact was found to 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. Unfortunately, this contact has shown poor thermo-mechanical ruggedness in press packed application. The combination with copper layer leading to PtSi-TiW-Ni-Cu contact stack has improved the ruggedness and decreased the contact resistance compared to that of the traditional aluminum contact. It was also found that without the PtSi layer, the device parameters like forward voltage drop are poor. Moreover, the influence of contact composition and thickness on thermal behaviour of the diode as a whole was found. Further research is directed to the optimization of the process in order to carry out a device with copper contact that outperforms the traditional aluminum in terms of both the quality and cost.

ULTRATHIN MOVPE GROWN InAs LAYERS IN GaAs CHARACTERIZED BY PHOTOMODULATED REFLECTANCE SPECTROSCOPY

P. Hazdra , J. Voves , E. Hulicius[*] and J. Pangrác[*]
[*]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

Photomodulated reflectance (PR) spectroscopy in combination with photoluminescence and photocurrent measurement was used for the characterisation of highly strained submonolayer and supermonolayer multiple InAs quantum wells (MQW) and modulated InGaAs layers on GaAs grown by metal-organic vapor phase epitaxy (MOVPE). Photomodulated reflectance was measured at room temperature using the standard set-up consisting of the tuneable monochromatic probe light source provided by a tungsten-halogen

lamp and the JY640 0.64 m focal length single grating monochromator. The modulation light source made by an unfocussed 5 mW red HeNe laser mechanically chopped at 626 Hz. The reflected probe beam was measured by a cooled Ge detector protected from any scattered laser light by a high pass filter. The weak electrical signal was recorded using standard lock-in technique. Structures were grown in AIXTRON 200 MOVPE reactor at 500°C on (100) oriented GaAs substrates by periodic interruption of the InAs and GaAs growth. The layers were analyzed by X-ray diffraction and scanning tunneling microscopy. The origin of various PR spectral features was proposed using simulation of electronic states in these structures with a theoretical model accounting for influence of stress and quantum states coupling. Optical transitions between ground and excited states identified on a 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 (~35%) near infrared (1.1μm) lasers. Presented work is a part of the grant project focused on identification and explanation of strong interaction between InAs δ-layers in the multiple structure, which is responsible for the energy shift and enhanced optical quantum efficiency.

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 heterostructures suitablefor 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 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***, **K. Bušek**
* 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 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**, **K. Bušek**
* 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 PLANARWAVEGUIDES IN GLASS AND LITHIUM NIOBATE SUBSTRATES

V. Jeřábek, J. Špirková*, **Z. Burian**, J. Čtyroký**, L. Salavcová*, M. Míka* P. Třešňáková*, **V. Drahoš, K. Bušek**
* Dept. of Inorganic Chemistry, ICTP.
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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 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 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

ELECTROMAGNETIC COMPATIBILITY IN MICROSYSTEM DESIGN

J. Novák, J. Foit

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

The project is targeted at creating design rules for digital integrated circuits, especially of the VLSI density class, taking care of electromagnetic compatibility (EMC). Both passive and active EMC is treated, with a stress put on the differences between "classical" macroscopic circuits and systems, and integrated circuits and microsystems. An integrated test structure was developed which is currently being prepared technologically in the form of measurement samples. Measurement of the samples will provide a basis for evaluation of the theoretical results in terms of real circuits behaviour and final formulation of design rules set.

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. Microsensors for UV radiation of a few types are supposed to be developed: 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
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.

POLYAPPLY – THE APPLICATION OF POLYMER ELECTRONICS TOWARDS AMBIENT INTELLIGENCE

M.Husák

Project support: EC 6th Framework Program Nr. 507143

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…

TARGET – TOP AMPLIFIER RESEARCH GROUPS IN A EUROPEAN TEAM

M.Husák

Project support: EC 6th Framework Program Nr.507893

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.

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 thermomechanical simulations of the sensor structures are performed using Memcad and CoventorWare from Microcosm Technologies.

RESEARCH GRANTS AND CONTRACTS

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Grant no.IAA1010318, Academy of Sciences of the Czech Republic
Project Manager: **P. Hazdra**

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Grant no. SfP-974172, EU NATO Science for Peace Programme.
Project Manager: T. Lalinský (Slovak Academy of Science, Institute of Electrical Engineering, Bratislava, (Dept. of Microelectronics: **M. Husák)**

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Grant no. 102/03/0619, Grant Agency of the Czech Republic
Project Manager: **M. Husák**

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Research Programme no. JD MSM 210000012, Ministry of Education
Project Manager: Konvičková (Faculty of Mechanical Engng., CTU in Prague)
(Dept. of Microelectronics: **M. Husák**)

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Research Programme no. JB MSM 210000015, Ministry of Education
Project Manager: V. Haasz (Dept. of Measurements, FEE- CTU in Prague)
(Dept. of Microelectronics: **M. Husák**)

Formation and Monitoring of Environment
Research Programme no. DN MSM 212300016
Project Manager: R. Bálek (Dept. of Physics, FEE- CTU in Prague)
(Dept. of Microelectronics: **M. Husák**)

Application of Platinum Silicide in Power Silicon Devices
Grant no. CTU 0407613, CTU in Prague
Project Manager: **D. Kolesnikov**

Sensors and Microsystems with Piezoresistive Thin-Film Layers for the Measurement of Mechanical Quantities at High Temperatures
Grant No. CTU 0407713, CTU in Prague
Project Manager: **P. Kulha**

Reasoning and Control in Production
Research Programme no. JD MSM 212300013, Ministry of Education
Project Manager: V. Mařík (FEE-CTU in Prague)
(Dept. of Microelectronics: **Z. Rozehnal**)

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

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

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

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

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

EDUCATIONAL GRANTS AND CONTRACTS

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ON-Semiconductor, Rožnov pod Radhoštěm
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CAKL Jiří	Planar Optical Waveguides for Integrated Optics
DOLEŽAL Tomáš	Design of Evaluation Board for Motor Control with DSP 56F805
DRBAL Ondřej	Measurement of Delay between EEG Signals
CHROMEK Ondřej	Searching of Forants in Speech
JELÍNEK Tomáš	Differential Kepstral Detector of Speech Activity
JÍNA Pavel	Control of charging Individual Battery Cells
KELBICH Milan	Model Protection of a Space
KOHOUT Martin	Processing of Audio and Video Signals Using FPGA
KSELÍK Milan	Integrated Functional Blocks for Current Mode Circuits
OLEXA Michal	Noise Reduction in Speech
ŘÍHA Pavel	Design of Pheriphery for Motor Control with DSP 56F805
SUCHÁNEK Pavel	Sensor System for Measurement of Pressure, Temperature and Velocity
ŠVRČEK Miroslav	Active Optical Channel Waveguides on Glass Substrates
TŘEBICKÝ Tomáš	Simulation of Transport in Quantum Structures
VALENSKÝ Martin	Waveform Generator with Microprocessor 68336
VOJÁČEK Antonín	Kalman Filtrering for Speech Enhancement
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ZEJBRDLICH Jiří	Analysis of EEG to Evaluate the Possibility of Stimulus Classification
ZLATNÍK Petr	Wiener Filtering for Speech Enhancement
BOUŘA Adam	Design of Electronic Acquisition Circuits for Pressure Sensor
JAKUBEC Martin	Application of Data Transfer through Power Line for the Control of Railroad Model
KAŠKA Radovan	Design of Integrated Sensor Unit for Measurement of Air Flow
MAZANEC Tomáš	LNS Implementation of Echo Compensation for FPGA
ŠPAČEK Tomáš	Electronics for Blood Pressure Control
VERNER Jiří	Music Synthesis with DSP 56 800