NANOSIL

Silicon-based nanostructures and nanodevices for long term nanoelectronics applications

Network of Excellence

WP5: Integration and spreading of excellence

M5.1 "Who is Who Guide"

Main Author(s): Denis Flandre, Valeriya Kilchytska (UCL)

Stand: February 2010 (update)

Project funded by the European Commission under grant agreement n°216171

LIST OF CONTRIBUTORS

Partner	Acronym	Organization Legal Name	Name of the contact
2	GRENOBLE INP	***Grenoble Institute of Technology***	Dr. Mireille Mouis
3	WARWIK	***University of Warwick***	Dr. David Leadley
4	RWTH	***RWTH Aachen University***	Dr. Bernd Spangenberg
5	KTH	***Kungliga Tekniska Högskolan***	Prof. Mikael Ostling
6	IUNET	***Consorzio nazionale interuniver-sitario per la nanoelettronica***	Dr. David Esseni
7	UCL	***Université Catholique de Louvain***	Prof. Denis Flandre
9	CEA	***Commissariat à l'énergie atomique***	Dr. Marc Sanquer
11	ISEN	***IEMN-ISEN***	Dr. Emmanuel Dubois
12	UPS	***Université Paris Sud 11***	Dr. Philippe Dollfus
13	AMO	***Gesellschaft für angewandte Mikro- und Optoelektronik mbH***	Dr. Heinrich Gottlob
14	FZJ	***Forschungszentrum Juelich***	Dr. Siegfried Mantl
16	TUBS	***Technical University Braunschweig***	Prof. Bernd Meinerzhagen
17	USTUTT	***UNIVERSITAET STUTTGART***	Dr. Alim Karmous
18	NCSR "D"	***National Center for Scientific Research "Demokritos"***	Dr. Androula Nassiopoulou
19	TYNDALL	***Tyndall National Institute, University College Cork***	Prof. Jean-Pierre Colinge
20	WUT	***Warsaw University of Technology***	Prof. Romuald Beck
21	URV/UGR	***Universitat Rovira I Virgili University of Granada***	Prof. Benjamin Iniguez Prof. Francisco Gamiz
22	CHALMERS	***Chalmers tekniska högskola AB***	Prof. Olof Engstrom
23	EPFL	***Ecole Polytechnique Fédérale de Lausanne***	Prof. Adrian Ionescu
24	ETHZ	***Swiss Federal Institute of Technology***	Prof. Andreas Schenk
25	SNPS	***SYNOPSYS Switzerland LLC***	Dr. Fabian Bufler
26	GU	***The University of Glasgow***	Prof. Asen Asenov
27	LIVUNI	***University of Liverpool***	Prof. Steve Hall
28	UNEW	***University of Newcastle upon Tyne***	Dr. Sarah Olsen
29	SiNANO	***SiNANO Institute***	Mrs Pascale Caulier

Name of the organization			
Organization Legal name		***Grenoble Institute of Technology***	
Organization Short name		***Grenoble INP***	
Partner number		***2***	
Department/Faculty/Institute/Laboratory name		***FMNT***	
Internet homepage		***http://fmnt.online.fr/***	
Contact person for additional information			
Name: MOUIS	***First name: Mireille***	***Title: Dr***	***E-mail address: Mouis@enserg.fr***
Brief description of your organization			

The Federation for Micro Nano Technologies (FMNT) clusters the 4 academic laboratories which are involved in the field of micro-nano-electronics on the Minatec Campus in Grenoble, namely LTM, LMGP, SPINTEC and IMEP-LAHC. Their expertise ranges from materials and technology to devices, circuits and integrated micro-nanosystems. It covers:

- *Synthesis and characterization of functional materials, including advanced methods for the deposition of high-k dielectric materials with in situ control and deposition of 2D or 3D nanostructured materials using UV laser interferometry,*
- *Development of processes for nanoelectronics, with special focus on self organized growth of nanodots and nanowires and integration in devices,*
- *Device physics and extensive electrical characterization: mobility extraction, with in depth analysis of the scattering mechanisms, from electrical measurement in a wide range of temperature (10K-400K) at package or wafer level ; energy and depth resolved spectroscopy of interface states and defects in the gate dielectric, noise measurements (LF, RTS, shot noise), reliability…*
- *Near-field electrical characterization of nanostructures,*
- *Simulation of nanodevices and development of compact models of advanced devices (MUGFETs, quasi ballistic regime…).*

FMNT and CEA/INAC are co-operating a technology platform (PTA), which brings it support to research oriented projects.

PROCESSING

Equipment	Techniques/competences
• Etch platform with p-Si, oxide, metal and high k plasma chambers with high temperature process capabilities (250°C).	• Plasma patterning • In situ diagnostics & real time monitoring • Quasi *in situ* XPS analysis for plasma etching process analysis

CHARACTERIZATION & MODELLING

Equipment	Techniques/competences

• Angle Resolved X-ray Photoelectron Spectroscopy (ARXPS) system for 300 mm wafer size • 3D Atomic Force Microscope • Atomic Force Microscope (AFM) under controlled atmosphere (ambient temperature) • Laser interferometer / vibrometer • 200mm Cryogenic set-up for on-wafer electrical characterization (10-350K, DC-50GHz) • 300mm set-up for on-wafer electrical characterization (ambient, DC-150GHz) • Magnetoresistance and Hall effect set-up (PLCC mounting, 4-400K, 0-9T). After 09/2008. • Several set-ups for Charge Pumping, I-V-ω, G-V-ω measurements, pulsed I-V • Low-Frequency (LF) and Random Telegraph Signal (RTS) noise measurement • Self-consistent simulation of devices using the Non Equilibrium Green Function (NGEF) formalism • Band structure calculations (DFT)	• Surface analysis • Line Width Roughness and critical dimension metrology on patterned surfaces • Electrical modes of the AFM (STM, SGM, TUNA, EFM, MFM …), control in the x-y-z directions allowing local I-V measurements • Surface morphology, dynamic characterization of MEMS/NEMS structures (vibration modes…) • Improved techniques for the extraction of transport parameters and development of associated models, • Improved techniques for the study of thin SOI film and multiple gate devices • RF parameter extraction • Hall and magnetoresistance mobility extraction… • Characterization of interface states, depth resolved profiling of the trap density in thin dielectric layers… • Characterization of defects • Quantum transport in nanodevices, influence of local inhomogeneities (roughness, remote charges…), phonons… Influence of magnetic field. • Account for non standard materials, orientations, etc…

Name of the organization			
Organization Legal name		***University of Warwick***	
Organization Short name		***Warwick***	
Partner number		***3***	
Department/Faculty/Institute/Laboratory name		***Dept. of Physics***	
Internet homepage		***go.warwick.ac.uk/silicon***	
Contact person for additional information			
Name: Leadley	***First name: David***	***Title: Dr***	***E-mail address: d.r.leadley@warwick.ac.uk***
Brief description of your organization			
The Warwick Nano-Silicon Group is focused on the epitaxial growth of silicon and germanium based layer structures and has established a reputation for this over some 20 years, both in the UK and on the world stage. Most of our work is in collaborative projects with partners from UK and other European universities, advanced research institutes such as IMEC and LETI, and from industry. *Our specific expertise is in:* ** Epitaxial growth of Si, SiGe alloys and Ge layers by MBE and CVD, including n- and p-type doping for both active regions and strain-tuning buffer layers* ** Structural characterisation of layers, including XRD, TEM, SIMS and ellipsometry* ** Electrical characterisation of simple test structures and fully processed devices* ** Magnetotransport measurements of low dimensional structures including quantum Hall effect and correlated electron systems*			

PROCESSING

Equipment	Techniques/competences
• Solid state molecular beam epitaxy (SS-MBE) V100S • Reduced pressure chemical vapour deposition (RP-CVD) ASM Epsilon 2000E	• Epitaxial growth of Si, Ge C and related alloys • Investigation of strained layers and of strain tuning buffers

CHARACTERIZATION & MODELLING

Equipment	Techniques/competences
• Variable temperature probe station plus parameter analyzer and CV measurement equipment • Cryomagnetic system 14T, 0.3K • Low energy SIMS, using O_2 and Cs • Panalytical X'Pert Pro MRD for X-ray diffraction • JEOL 2000fx TEM • Zeiss SUPRA 55-VP FEGSEM	• Electrical characterization (CV, IV, 1/f noise) of silicon based materials and devices, between room temperature and 4K • Low temperature magnetoresistance, in fields up to 14 T and temperatures 300 to 0.3 K • Physical characterization of silicon based materials by SIMS, XRD, TEM, defect etch, AFM, SEM, ellipsometry

Name of the organization: RWTH Aachen University – Institut fuer Halbleitertechnik (IHT)			
Organization Legal name	***RWTH Aachen University***		
Organization Short name	***RWTH***		
Partner number	***4***		
Department/Faculty/Institute/Laboratory name	***Institut fuer Halbleitertechnik***		
Internet homepage	***www.iht.rwth-aachen.de***		
Contact person for additional information			
Name:	***First name:***	***Title***	***E-mail address:***
Spangenberg	*Bernd*	*Dr. rer. nat.*	spangenberg@iht.rwth-aachen.de
Berghoff	*Birger*	*Dipl.-Ing.*	berghoff@iht.rwth-aachen.de

Brief description of your organization

The main focus of the research activities at the Institute of Semiconductor Electronics (IHT) is generally directed to the exploration of future potentials of semiconductors for optic and electronic application in the range of information and communication technology (ICT), life science and renewable energy. Enabling technologies pursuit are nanotechnology and optoelectronics. With a focussed interdisciplinary approach the IHT is currently engaged in three distinct Silicon based areas:

- *Silicon photonics including terahertz technology,*
- *emerging silicon nanoelectronics*
- *3rd generation photovoltaics, especially nanotechnology for PV*

forming a key technology platform for innovation in strategic markets of the future. Recently potentials of carbon electronics have been started to be evaluated, too. The scientific projects at the IHT are entirely supported by third party financing. As a consequence the institute is involved in a series of research projects on national and European level, either as Partner or as Project coordinator. This link to industry has led to a significant patent portfolio and the spin-off of two SMEs.
Since 1990 the IHT has published more than 400 papers in refereed journals (isi-index) with a citation frequency of more than 6800.

PROCESSING

Equipment	Techniques/competences
• silicon front end processing including electrical characterisation equipment, • electron beam lithography ≤ 50nm, • ion implantation 20-350 kV, • UV-Nanoimprint, • dry etching, • Remote-PECVD, LPCVD and RTP, • Si-based quantum wells and dots, • pre- and post processing wafer sawing	• Fabrication and characterization of silicon-based nanodevices. • Self-assembling of Si/SiO2 quantum wells for tandem solar cells and quantum dots for resonant tunnel devices by LPCVD, RTP.

CHARACTERIZATION & MODELLING

Equipment	Techniques/competences
• CV- and IV-measurements • low temperature (4.2-77 K) measurement • SEM (JEOL 6700F) with EDX	• • •

• AFM • PL and μ-PL (≤ 10μm-spot size)	

Name of the organization			
Organization Legal name		***Kungliga Tekniska Högskolan***	
Organization Short name		***KTH***	
Partner number		***5***	
Department/Faculty/Institute/Laboratory name		***School of Information and Communication Technology Department of Microlectronics and Applied Physics***	
Internet homepage		***http://www.ict.kth.se/MAP/***	
Contact person for additional information			
Name:	***First name:***	***Title:***	***E-mail address:***
Mikael	***Östling***	***Prof***	***ostling@kth.se***
Per-Erik	***Hellström***	***Docent***	***pereh@kth.se***
Brief description of your organization			
KTH, Royal Institute of Technology is Sweden's oldest and largest technical university with more than 17000 students, about 250 full professors and in total 3000 employees. The school of information and communication technology, ICT, is located at the new campus in Kista, a centre for Sweden's ICT industry. The ICT school has it's own cleanroom facility with full wafer processing capability including stepper lithography for Si nanoelectronics on 100, 150 and 200mm sizes. On 100 mm wafers the processing capability includes full MOSFET fabrication and patterning of lines down to 30 nm width is achieved with Sidewall Transfer Lithography combined with I-line stepper lithography. FinFETs, Ultra-Thin-Body and bulk devices can be made in the cleanroom. The cleanroom comprises basic research, applied research and pilot production in a wide perspective of nanotechnology materials.			

PROCESSING

Equipment	Techniques/competences
Equipment is for 100 mm wafers unless specified. • G and I-line stepper lithography on 100, 150 and 200 mm wafers • AMAT P5000 etching tool with 3 chambers for dielectrics, poly-Si and metal etching. • LPCVD: SiN, LTO, in-situ phosphor doped poly-Si, undoped a-Si and poly-Si, TEOS • SiO_2 gate dielectric down to t_{ox}=2.4 nm • RTA • AMAT Centura system with deep Si etch chamber and dielectric etch chamber for 200 mm wafers. • ASM Epsilon SiGe CVD reactor	• Sidewall Transfer Lithography to pattern lines with width down to 30 nm • Full process line for nanoscale MOSFET fabrication on 100 mm wafers with 3,5 month turn-around-time. • Processing on bulk and Ultra-Thin-Body SOI including Tri-gate and FinFET devices • Competence in low temperature dopant segregated Schottky barrier MOSFETs • Competence in PtSi and NiSi integration in MOSFETs • One-level metallization on MOSFETs • Competence in SiC bipolar transistor fabrication. • Competence in selective strained SiGe growth on patterned Si wafers.

CHARACTERIZATION & MODELLING

Equipment	Techniques/competences
• HRSEM, FIB and HRTEM • SIMS • HRXRD • ISE software • Wire bonding (thick and thin)	• Competence IV, CV and high frequency S parameter measurements • Device Modelling

Name of the organization	
Organization Legal name	***Consorzio nazionale interuniversitario per la nanoelettronica***
Organization Short name	***IUNET***
Partner number	***6***
Department/Faculty/Institute/Laboratory name	***Consorzio nazionale interuniversitario per la nanoelettronica***
Internet homepage	***http://www.iunet.it/***

Contact person for additional information			
Name: David	***First name: Esseni***	***Title: Dr.***	***E-mail address: esseni@uniud.it***

Brief description of your organization
The "Consorzio Nazionale Interuniversitario per la Nanoelettronica" (IUNET, Italian Universities Nano-Electronics Team), is a non-profit, private Organization, aimed to lead and coordinate the effort of the major Italian University Teams in the field of Silicon Based Nanoelectronic Device Modeling and Characterization. The groups involved in the NANOSIL Project are the following: ARCES-University of Bologna, DEIT Politecnico of Milano, DII-University of Pisa, and DIEGM-University of Udine. They offer renowned and complementary expertise in the field of modeling, simulation design, characterization of CMOS-based nanometer-size electronic devices. Their technical reputation is confirmed by the many IST projects where they have been recently involved under FP6 (PULLNANO, EMMA, SINANO, FINFLASH), under FP5 (DEMAND, NANOTCAD, NESTOR, PHANTOMS, ULIS) as well as many other European and national projects.

CHARACTERIZATION & MODELLING

Equipment	Techniques/competences
• State-of-the-art characterization equipments for low frequency device measurements • State-of-the-art characterization equipments for high-frequency, RF measurements • Low temperature measurements • Single device and statistical characterization of Non-Volatile Memories	• Advanced CMOS and Non-Volatile memories characterization • Advanced CMOS modeling: o Semi-classical Monte Carlo modeling; o Full quantum transport; o Atomistic approaches • Advanced Non Volatile Memory modelling: o Phase Change Memories o Nitride based memories; o Nanocrystal memories;

Name of the organization			
Organization Legal name		***Université Catholique de Louvain***	
Organization Short name		***UCL***	
Partner number		***7***	
Department/Faculty/Institute/Laboratory name		***Electrical Engineering, Microelectronics (DICE) / Microwave (EMIC) laboratories***	
Internet homepage		***http://www.dice.ucl.ac.be http://www.emic.ucl.ac.be***	
Contact person for additional information			
Name: Flandre	***First name: Denis***	***Title: Prof.***	***E-mail address: denis.flandre@uclouvain.be***
Brief description of your organization			
The UCL DICE and EMIC Laboratories are part of the CERMIN (UCL Research centre for micro- and nano- materials and electronics devices). They form a multidisciplinary team, involving device physicists, technologists and experimentalists, as well as analog, RF and digital circuit designers. Current activities focus on innovative device fabrication, extensive DC to RF characterization and simulation, including: CMOS/bipolar/diodes on SOI, advanced architecture MOSFETs (multiple-gate, e.g. planar DG, FinFETs, SON), Nano-MOSFETs with low-barrier Schottky source-drain contacts, Quantum Single-electron-memories and transistors, Ballistic transistors, Magnetic devices, various MEMS and sensors. In FP6 NoE "SINANO", UCL led the WP2 "non-classical Si-based nano-MOSFETs".			

PROCESSING

Equipment	Techniques/competences
• UCL laboratories are equipped with a complete pilot fabrication line of about 1000 m^2 (Winfab.eu), for the rapid prototyping and validation of new fabrication steps and of new integrated devices or Microsystems, on silicon / SOI substrates (3 inches)	• Full fabrication process for 1µm Single/Double gate SOI MOSFETs and CMOS ICs (more than 10000 gates) since early 90's, namely fully-depleted and Gate-all-Around (GAA) technologies. Silicon-on-nothing (SON) and innovative double-gate process developed within FP6 NoE SINANO. • Thin silicides on SOI: Er-Pt (for low Schottky barriers), Ni (for low ohmic and RF devices)… • Quantum wires, Single-Electron-Memories, Single-Electron-Transistors… with nano-dimensions defined by e-beam lithography, nanoimprint and controlled oxidations.

CHARACTERIZATION & MODELLING

Equipment	Techniques/competences
• A large set of characterization tools is available (for complete list, refer to www.emic.ucl.ac.be/WebBooking). • Electrical measurement set-ups cover a large range of frequencies (from DC up to	• The Microelectronics and Microwaves laboratories have been collaborating since 1991 on the measurement and extraction of static and dynamic behaviors and parameters for SOI MOSFETs, e.g.

110 GHz) and temperatures (from few mK up to 400°C) on wafer-scale (semi-automatic prober) as well as packaged circuits levels. • Semiconductor simulation tools (ISE, Silvaco, Synopsis…). • Electro-magnetic simulations. • Complete CAD tools for integrated circuits and systems design	statistical digital/analog/RF figures-of-merit, floating-body and substrate time constants, distortion, matching, 1/f noise, crosstalk. • DC and RF behaviors of SOI MOSFETs such as Fully and Partially Depleted, Body Contacted and Dynamic Threshold as well as multiple-gates FETs as DG MOSFETs; SON MOSFETs and FinFETs.· • Atlas 3-D module used for simulating GAA MOSFETs and FinFETs. • Compact modeling of SOI fully-depleted single-gate, double-gate and graded-channel MOSFETs and RF macro-modeling. • Ultra-Low-Power innovative design concepts for SRAM, MTCMOS, low leakage CMOS, analog blocks (voltage reference, charge pump, low leakage diodes, power management, RFID…)

Name of the organization			
Organization Legal name			***Commissariat à l'énergie atomique***
Organization Short name			***CEA***
Partner number			***9***
Department/Faculty/Institute/Laboratory name			***DSM-INAC-SPSMS-LaTEQS***
Internet homepage			***http://www-drfmc.cea.fr/en/Phocea/Vie_des_labos/Ast/ast_groupe.php?id_groupe=208***
Contact person for additional information			
Name: Sanquer	***First name: Marc***	***Title: Dr.***	***E-mail address: marc.sanquer@cea.fr***
Brief description of your organization			
Our Laboratory of Quantum Electronic Transport and Superconductivity (LaTEQS) is part of the Institute for Nanosciences and Cryophysics (INAC) at the CEA-Grenoble. The permanent staff consists in 7 researchers and 4 engineers and technicians. The research activity of our laboratory embraces various aspects of mesoscopic quantum transport in nanostructures and low-dimensional systems: silicon nano-MOSFETs made by state-of-the-art nanofabrication techniques, self-assembled semiconductor nanostructures, carbon nanotubes, superconducting thin films, hybrid systems combining superconductors, normal conductors, and ferromagnets. In these systems we study the physics of individual confined electrons, as well as quantum phenomena resulting from strong electron-electron correlations (e.g. due to superconductivity, Coulomb interaction, Kondo effect, etc.). Our experimental tools range from low-noise electrical measurements, to current noise detection, specific-heat measurements, and scanning-electron microscopy. Also, we are currently developing advanced techniques for time-resolved electrical measurements involving high-frequency signals			

PROCESSING

Equipment	Techniques/competences
• Access to flexible clean room facilities (PTA clean room) including e-beam lithography.	• • •

CHARACTERIZATION & MODELLING

Equipment	Techniques/competences
• Several dilution refrigerators equipped for low noise-low signal electrical transport and noise measurements (T down to 30mK) • Ultrasonic bonding, Probe station • STM at very low temperature (T=100mK)	• quantum nanoelectronics • quantum mesoscopic physics • ultimate CMOS devices

Name of the organization			
Organization Legal name		***IEMN-ISEN***	
Organization Short name		***IEMN-ISEN***	
Partner number		***11***	
Department/Faculty/Institute/Laboratory name			
Internet homepage		***www.iemn.univ-lille1.fr***	
Contact person for additional information			
Name: Dubois	***First name: Emmanuel***	***Title: Dr, Dir. Res. at CNRS***	***E-mail address: emmanuel.dubois@isen.iemn.univ-lille1.fr***
Brief description of your organization			
IEMN has approximately 165 permanent research scientists, 94 engineers and technical staff, 140 PhD students and 35 post-docs. IEMN has developed a recognized expertise over a wide spectrum of research fields covering advanced device fabrication (compounds and silicon), material physics, circuit design, optoelectronics, nanostructures, molecular electronics, microsystems, acoustics and sensors. The coexistence of specialists in all these research areas increases exchange of knowledge between very different disciplines where IEMN has acquired the expertise required for the design of non-conventional CMOS materials and devices. This work is carried out with numerous national and international partners from the research as well as with the industrial world. IEMN is equipped with excellent research facilities installed over 13000 m2, including 1400 m2 of clean room. The main IEMN group associated to the activity of NANOSIL is the Silicon Microelectronics Group that has developed main research themes that cover i) the design and fabrication of nanometric MOS architectures, ii) the modelling and simulation of silicon processes/devices and iii) the design of analogue integrated circuits.			

PROCESSING

Equipment	Techniques/competences
• MBE growth: - 1 RIBER Compact 21 (solid sources) - 1 RIBER 32P (gas sources) - 1 RIBER compact 21 (Carbone based epilayers) • Ion Implantation: - 1 EATON GA204 ion implanter - 2 RTA • LPCVD: - 5 TEMPRESS tubular furnaces - 1 furnace for nanowires • Sputtering: 4 equipments for magnetic and piezo materials • Organic materials platform: 3 gloveboxes with spinning coater and evaporator. • E-beam lithography: - 1 LEICA EBPG 5000+ - 1 VISTEC EBPG-5000plusES • Optical lithography: - 3 mask aligners - 1 double face aligner - 1 substrate bonder	• **Material Resource** Molecular Beam Epitaxy equipment: one is equipped with solid sources, the otherwith gas sources for the elements V, and solid sources for elements III. In order to characterize materials and epitaxial heterostructures, • **Deposition resources:** We gathered under the terminology "Resource Deposition" all of the physical techniques of deposition such as for example, the techniques of evaporation or cathode sputtering of various metals or alloys... as well as chemical techniques for metals deposition, dielectrics or various materials such as the LP-CVD, the PE-CVD and the electrolytic deposition. • **Etching Resource** We have an "Etching Resource" in which are gathered the techniques of dry etching (plasma technique) and the wet etching techniques (chemical techniques). Thus, our dry etching

• Wet etching: - 5 chemical benches for Si - 4 chemical benches for III-V compounds • Dry etching : - XeF2 etching - 1 STS ICP for Si deep etchning - 1 OXFORD RIE-ICP for III-V compounds - 1 OXFORD RIE etching - 1 IBE etching • PECVD: 1 OXFORD PECVD system • Metallization: - 4 UHV evaporators - 1 automatic UHV evaporator - 2 sputtering equipments - 1 multi cathode sputtering equipment - 1 evaporator for polymers - 1 RTA • Sample cleaning, dicing, polishing, bonding: - supercritical CO2 drying - chemical and mechanical polishing - 2 wafer dicing saws - 2 bonding machines	equipment, have 6 frames of RIE, ICP or micro waves type. But each equipment is dedicated to a type or to a family of materials: Si, oxides and silicon nitrides, arseniured, phosphorated, nitrided, antimoniated, metals... in order to avoid cross material contaminations. Moreover, we are equipped with a chemical etching by xenon difluoride, allowing etching selectively Si / SiO2. About wet etching, we have 8 dedicated etching stations, under sorbonne. The main available baths are : KOH, TMAH, HF, and we have dedicated locations to the organic acids, HNO3, H2SO4, etc... • **Lithography resource** Under "Lithography Resource", are gathered the optical and e-beam lithography means : ► optical lithography : single face alignment and double face equipment, make possible to carry out the alignment of masks and the exposure with UV250 and UV400. Thanks to the use of adapted resins, it is possible to expose the submicron patterns. ► e-beam lithography : we have 2 e-beam equipments. Provided with proximity correction and simulation software, they carry out direct writing on substrates from 2 to 4 inches.

CHARACTERIZATION & MODELLING

Equipment	Techniques/competences
• Technology • 3 profilometers • optical microscopes, reflectometer… • spectroscopic ellipsometry • 2 SEM • 1 near field microscope • 1 large field AFM • Surface characterization (ESCA) • DDX, Hall effect, femtoseconde laser…	• **Analytical characterization** The material resource has physical techniques of characterisation such as the ESCA, equipped with sources making it possible to carry out XPS, UPS, and Auger analyses. We also have a double X-ray diffraction apparatus, a photoluminescence bench equipped with several sources (Argon laser,YAG, Xe lamps) and monochromators allowing to work from 0,2 to 1,7 µm, at temperatures ranging between 10 and 300K. A "femto-second" unit equipped with a pulsed source associated to a titanium-sapphire oscillator (700-1000nm, 100fs) and an optical parametric oscillator (1,1-1,65µm, 100fs). • **Microscopy, FIB** Latest generation FEG (Field Effect Gun) type Scanning Electronic Microscope. Provided with a Schottky type electron source we reach a resolution of 1,2nm@1kV and 1nm@15kV. Finally, in order to work on a nanotechnology level, we obtained a double beam microscope: STRATA DB 235. Thus, it is possible to carry out at the same time, micromachining (etching or deposition) using a Focused Ion Beam (FIB), and imagery using a Scanning Electronic Microscope (SEM). It is thus possible, in addition

	to the standard analyses applied to the laboratory, to carry out observations of transistor grid profiles, multi-layers structures crosses from there, or platinum deposition and TEM preparations.

Equipment	Techniques/competences
► Vector Network Analyzer are operating : from 30KHz to 110GHz in coaxial structure. from 50GHz to 110GHz and from 140GHz to 220GHz in guide structure. ► Pulse Vector Network Analyzer is operating from 1GHz to 50GHz with 100nsec of pulse duration. ► Noise measurement between 10MHz and 40GHz. ► Non Linear Vector Network Analyzer (600MHz to 20GHz). ► Noise measurements at 60GHz and between 75 and 110GHz. ► Power measurements at 60GHz and 94GHz with E/H plane tuners. ► Microwave signal generator up to 50GHz. ► Spectrum analyzer up to 50GHz. ► Programmable DC source/ monitoring working in static and pulse mode. ► Power meter in coaxial structure up to 50GHz working in CW and pulse (100nsec) mode. ► Power meter in guide structure up to 110GHz. ► Microwave Cryogenic probe station (30K-50GHz). ► High temperature microwave probe station (600K-40GHz	• RF characterization The first target of this joint service is to carry out the full electrical and microwave characterization of devices from the technology center in order to perform a feedback for technology. To do this, year after year, several experiments and experimental techniques have been developed over a wide frequency range, from DC to THz and for a wide temperature range from 30K to 600K. These experiments and experimental techniques can be summarized in these 6 following areas : ► DC and microwave small signal measurements. ► Noise characterisation ► Non linear characterisation ► Characterisation over a wide temperature range ► THz characterisation ► Electromechanical characterisation of MEMS This expertise applies to a wide range of microwave components such as passive devices,antennas and MEMs, and also active devicese.g. HBT (InP), HEMT (AsGa, GaN, InP), GaAs metamorphic HEMT, Si MOSFET, in addition to this some devices which are more complex integrating some functionalities (MMICs, amplifier for low noise or power applications, fast sampling applications etc.)

Name of the organization			
Organization Legal name		***Université Paris Sud 11***	
Organization Short name		***UPS***	
Partner number		***12***	
Department/Faculty/Institute/Laboratory name		***Institut d'Electronique Fondamentale***	
Internet homepage		***http://www.ief.u-psud.fr/***	
Contact person for additional information			
Name: Dollfus	***First name: Philippe***	***Title: Dr***	***E-mail address:*** ***philippe.dollfus@ief.u-psud.fr***
Brief description of your organization			
IEF (Institute of Fundamental Electronics) is a joint research unit between CNRS and University Paris XI. Located at the scientific center of Orsay, it is affiliated with the scientific departments ST2I and MPPU (Mathematics, Physics, Planet, Universe) of CNRS. The staff is composed of about 33 researchers, 52 professors and assistant-professors, 52 engineers, technicians and administratives, 70 PhD students, 20 non-permanent researchers including post-doctorate researchers, invited researchers, contractual staff, etc. IEF receives about 80 training students per year. The research carried out at IEF focuses on silicon-based nano-electronics (i), nanomagnetism and spin electronics (ii), micro-nanophotonics and optoelectronics either based on silicon or III-V semiconductors (iii), microsystems including their fabrication and characterization (iv), and autonomous systems and network systems. *The research group which participates in NANOSIL is involved in transport/device simulation and modeling of semiconductor nanodevices including nano-MOSFET, nanotubes and quantum dots.*			

CHARACTERIZATION & MODELLING

Equipment	Techniques/competences
• • •	• Semi-classical and quantum Monte Carlo simulation of nanodevices • Green's function approach to quantum transport in nanodevices

Name of the organization	
Organization Legal name	***Gesellschaft für angewandte Mikro- und Optoelektronik mbH***
Organization Short name	***AMO***
Partner number	***13***
Department/Faculty/Institute/Laboratory name	***AMO GmbH / AMICA***
Internet homepage	***http://www.amo.de***

Contact person for additional information			
Name: ***Gottlob***	***First name:*** ***Heinrich***	***Title:*** ***Dr.***	***E-mail address:*** ***gottlob@amo.de***

Brief description of your organization
AMO GmbH (Gesellschaft für angewandte Mikro- und Optoelektronik) is committed to applied research in the area of micro-, nano- and optoelectronics to enable innovative technologies and devices for emerging future applications in the area of communication, life and energy. AMICA (Advanced Microelectronic Center Aachen) is the research oriented nanolaboratory of AMO. The research is dedicated to silicon process technology with a strong focus on nanolithography and nanodevices. Further research activities cover silicon photonic devices and graphene nanodevices.

PROCESSING

Equipment	Techniques/competences
• 350m² experimental CMOS line, 6" compatible, SOI process, advanced e-beam and nanoimprint technology	• SOI Nano-CMOS devices down to 12nm • Triple-Gate devices down to 20nm • Metal-Gate technology for rapid material screening • Gate first high-k dielectric process integration • Advanced E-beam-Lithography with sub 10nm resolution • UV-Nanoimprint Lithography with sub 10nm resolution • Ni Silicide process for UTB devices • Silicon nanophotonic devices on SOI •

CHARACTERIZATION & MODELLING

Equipment	Techniques/competences
• Agilent: • Parameter analyzer, CV-measurements • CASCADE semiautomatic probe station • In-House development: High speed data acquisition, Transient recorder	• DC device characterization • HF/QSCV method • Charge pumping • Setup for measurements of ring oscillators • High temperature measurement system (up to 300°C)
• Silvaco and TCAD process simulation	• Process simulation for nano-devices

Name of the organization			
Organization Legal name		***Forschungszentrum Juelich***	
Organization Short name		***FZJ***	
Partner number		***14***	
Department/Faculty/Institute/Laboratory name		***Institute of Bio- and Nanosystems (IBN1-IT)***	
Internet homepage		***www.fz-juelich.de/ibn***	
Contact person for additional information			
Name: ***Mantl***	***First name:*** ***Siegfried***	***Title:*** ***Prof. Dr.***	***E-mail address:*** ***s.mantl@fz-juelich.de***
Brief description of your organization			
FZ- Juelich, *Institute of Bio- and Nanosystems (IBN1-IT) is part of the Helmholtz research center Juelich and performs application oriented basic research in the domains of information technology. The silicon related research activities concentrate on the investigation of new materials, e.g. strained silicon, high-k dielectrics, metal gates as well as on novel devices, e.g. Schottky barrier and planar NanoMOSFETs on SOI and nanowire transistors. For material synthesis CVD of SiGe, ALD for oxides and AVD for Nitrides, MBE (Si, Si-Ge, silicides, GaAs, AlGaAs), MOVPE (InP based materials) and laser deposition (high-k, ferroelectrics) are used. The thin films can be characterised with numerous methods, e.g. RBS, ion channeling, TEM, Raman spectroscopy, photoluminescence, AFM and STM. A 250keV and a 500 keV ion implanter as well as a 1.7 MeV Tandetron accelerator are available for ion implantation and analysis. The institute has a fully equipped clean room for the fabrication of microelectronic devices. Electrical and optoelectronic characterisation methods for devices are also available.*			

PROCESSING

Equipment	Techniques/competences
• Fully equipped clean room • Various ion implanters (up to 200mm) • Si-Ge CVD (200/300 mm wafers) • Aixtron Genus ALD (200/300 mm) • Aixtron Genus AVD (200/300mm) • Excimer laser ablation • Electron beam lithography • Sputtertool • etc.	• Ion implantation • ion beam analysis (RBS, Channeling) • CVD of SiGe • Atomic layer deposition of oxides • Atomic vapor deposition of nitrides • Laser ablation of oxides, nitrides • Molecular beam deposition (SiGe, oxides)

CHARACTERIZATION & MODELLING

Equipment	Techniques/competences
• Tandem accelerator • Transmission electron microscopy • XRD, SIMS, Raman • CV, IV, pulsed IV etc. • HF characterisation • Silvaco, Synopsis • etc.	• RBS, channeling • TEM, HRTEM with aberration corr. • XRD • Raman • AFM, STM • etc.

Name of the organisation			
Organization Legal Name		***Max-Planck-Institut für Mikrostrukturphysik***	
Organization Short Name		***MPI Halle (Subcontract from Juelich)***	
Partner Number			
Department		***Exp. Dept. II***	
Internet Homepage		***www.mpi-halle.de***	
Contact person for additional information			
Name: Reiche	***First name:*** Manfred	***Title:*** Dr.	***E-mail address:*** reiche@mpi-halle.de
Brief description of your organization			
The Max-Planck-Institut für Mikrostrukturphysik focuses primarily on solid state phenomena determined by small dimensions, surfaces and interfaces. Within the Exp. Dept. II the basic research is aimed at supplying the scientific understanding for the design and fabrication of improved or completely new materials, thus pushing the limits of nanoscience and nanotechnology. The materials dealt with include a variety of semiconductors, ferroelectrics and others. The silicon related research activities concentrate on the realization and characterization of strained silicon and other SOI-based materials (GOI) as well as the combination of dissimilar materials for the integration of microelectronics and photonics. The capabilities include methods to fabricate such materials and to process devices up to 200 mm wafer in diameter in a fully equipped clean room. Numerous methods to characterize the structural, mechanical, optical, and electrical properties of these materials are available.			

PROCESSING

Equipment	Techniques/competences
• Fully equipped clean room • Wafer bonding tools - also for aligned wafer bonding (Suss CL200, SB6, MA6/BA6) • LPCVD_ Tempress horizontal and vertical furnaces • PECVD_Oxford Plasmalab 80 • RTA • Dry Etching_Oxford Plasmalab 100 (also for low-temperature (cryo) etching) • Optical lithography • Electron beam lithography • Sputter tools • CMP tools	• Wafer bonding and layer transfer • CMP processing of different materials • Processing of nanostructures and devices

Characterization & Modelling

Equipment	Techniques/competences
• All techniques of electron microscopy • Raman Spectroscopy • XRD • Electrical measurement techniques • etc.	• TEM, HRTEM, analytical electron microscopy, Nanobeam Electron Diffraction • µ- and Nano-Raman Spectroscopy • AFM • etc.

Name of the organization			
Organization Legal name		***Technical University Braunschweig***	
Organization Short name		***TUBS***	
Partner number		***16***	
Department/Faculty/Institute/Laboratory name		***Institute for Electron Devices and Circuits***	
Internet homepage		***www.nst.ing.tu-bs.de***	
Contact person for additional information			
Name: ***Meinerzhagen***	***First name: Bernd***	***Title:*** ***Prof.***	***E-mail address:*** ***b.meinerzhagen@tu-bs.de***
Brief description of your organization			
The main research focus of the institute is the development and application of advanced numerical device modeling tools for Si and SiGe based devices. For more details please refer to the webpage.			

CHARACTERIZATION & MODELLING

Equipment	Techniques/competences
• 200 mm on wafer measurement equipment • 2D DD and HD general purpose device simulator GALENE III for Si/SiGe devices	Transport- and noise simulations based on MC-generated transport and noise parameters, Nonlocal models for impact ionization and band-to-band tunneling
• 2D Full-Band Monte-Carlo Simulator ELWOMIS	Efficient full-band simulation of general Si/SiGe devices, efficient hot carrier simulations using ELWOMIS as postprocessor
• 2D k.p Schrödinger-/Poisson-/Multisubband Boltzmann Transport Si/SiGe PMOS device simulator with direct (non MC) solution algorithms	Accurate simulation of Si/SiGe based nanometer scale PMOS devices including strain and orientation effects as well as magnetotransport. Verified results for many different strain and orientation configurations.

Name of the organization			
Organization Legal name		***UNIVERSITAET STUTTGART***	
Organization Short name		***USTUTT***	
Partner number		***17***	
Department/Faculty/Institute/Laboratory name		***Institut für Halbleitertechnik***	
Internet homepage		***http://www.iht.uni-stuttgart.de/***	
Contact person for additional information			
Name: ***Karmous***	***First name:*** ***Alim***	***Title:*** ***Dr.***	***E-mail address:*** ***karmous@iht.uni-stuttgart.de***
Brief description of your organization			
Universität Stuttgart (USTUTT) is one of the leading technical universities in Germany. Institut für Halbleitertechnik (IHT) is an institute of the University of Stuttgart which activities concentrate on the semiconductor engineering field. IHT research activities are focused on both fundamental and applied aspects of semiconductor materials. IHT explores new growth routes in order to improve the control over nanostructure and thin layer formations and investigate silicon germanium based future nano-electronic devices and quantum effect devices mainly intended to mm-wave and infrared applications. IHT have 300 m² clean room with facilities for material growth (MBE) and low thermal budget device processing.			

PROCESSING

Equipment	Techniques/competences
• Molecular Beam Epitaxy machine • Karl Suss MA6 Mask aligner • Reactive Ion Etching • Chemical wafer cleaning and etching facilities	• Growth of SiGe structures on patterned / unpatterned substrates. • Strain engineering and growth of relaxed SiGe layers • Substrate patterning by Photolithography and dry/wet Etching

CHARACTERIZATION & MODELLING

Equipment	Techniques/competences
• ***BIORAD PN 4300PC*** electrochemical CV-Profiler • ***LEO 1550*** Scanning Electron Microscope • ***Veeco AutoProbe M5*** Atomic force microscope • ***Sentech SpectraRay*** Ellipsometer • ***In Via*** Raman Microscope • Hall measurement set-up • ***Anritsu 3700*** Vector Network analyzer	• Defect characterization by selective electrochemical etching • Surface imaging • Surface morphological characterizations • Layer thickness measurements • Micro-Raman: Composition and stress determination for SiGe layers • Hall measurements: doping, mobility • High frequency S-parameters measurement up to 110 GHz

Name of the organization			
Organization Legal name		***National Center for Scientific Research "Demokritos"***	
Organization Short name		***NCSR "Demokritos"***	
Partner number		***18***	
Department/Faculty/Institute/Laboratory name		***Institute of Microelectronics (IMEL)***	
Internet homepage		***www.imel.demokritos.gr***	
Contact person for additional information			
Name: ***Nassiopoulou***	***First name:*** ***Androula***	***Title: Dr, Director of IMEL***	***E-mail address:*** ***A.Nassiopoulou@imel.demokritos.gr***
Brief description of your organization			
IMEL (Institute of Microelectronics) is one of the eight Institutes of the National Center for Scientific Research (NCSR) "Demokritos", Athens-Greece, devoted to silicon technology. It is currently established as the National Center of Excellence in micro-, nanofabrication, nanoelectronics and MEMS. Its facilities and infrastructure include a fully equipped silicon processing laboratory in a clean room area, nanolithography equipment, design tools, sensor fabrication equipment and characterization and testing facilities for materials, devices, circuits and systems. Research activities at IMEL are structured in the following 3 programmes: *-Micro and Nanofabrication, including patterning technologies, lithographic polymers and processes, front-end processes for micro- and nanodevices and thin films for electronics and MEMs* *- Nanostructures for nanoelectronics devices and sensors, including semiconductor nanocrystals embedded in dielectrics, nanowires and their applications, memory devices, molecular materials as components of electronic devices etc.* *- Sensors and MEMs. They include development of materials, technologies, and devices, as well as design activities. Examples are: gas and liquid flow sensors, gas sensors, accelerometers, pressure sensors, thermoelectric devices, energy harvesting devices, bio-sensors, and thin film devices.*			

PROCESSING

Equipment	Techniques/competences
Silicon processing laboratory in a clean room area of 500 m^2, equipped with the following: • 4 laminar flow chemical benches • 7 horizontal hot-wall furnace tubes • 2 horizontal LPCVD tubes for nitride, oxide (TEOS), polysilicon • 1 horizontal LPCVD tube for LTO • Ion Implanter (EATON medium current, 200 KeV) • Optical lithography systems (resolution down to 0,6 μm) • Reactive Ion Etcher • Metallization equipment • (thermal, e-gun evaporation, sputtering) • Process inspection equipment	• Nanopatterning technologies • Plasma etching • Growth of metals and dielectrics • Growth of polycrystalline and nanocrystalline Si • Growth of Si nanostructures embedded in a dielectric matrix, ordering of nanostructures • Fabrication of MOS capacitors and MOSFETs • Nanocrystal non-volatile memories • Micromachining, sensor fabrication, microfluidics • Molecular materials and devices • Thin film devices

Processing equipment not in clean room: • High Density Plasma Etcher • Different thin film deposition systems • (Sputtering, MOCVD)	

CHARACTERIZATION & MODELLING

Equipment	Techniques/competences
Electrical • Several probe stations • HP measuring systems (4142B, 4084B, 8110A, 700i series, 4140B, 4284, 4192A, 34401, 16500A) • Keithley measuring equipment (230, 220, 617, 195A, 6517A) • Oxford optistat cryostat for temperatures in the range 4.2-320K • Wafer level cryogenic measurements (Janis probe station) • Cascade Microtech Summit 9101 Analytical Probe Station for 150mm wafers • Anritsu 37269D Vector Network Analyzer 40MHz-40GHz **Optical** • Jobin Yvon spectrometer,wavelengths 300-1600nm • Ar+ laser • **HeCd 10mW 325 nm laser** • UV lamp with monochromator • Oxford optistat cryostat, 4.2-320K • FTIR: Bruker, Tensor 27 **Morphology, structural characterization** • Leo 440 SEM with Elphy/Raith e-beam lithography • attachment, JEOL JSM-7401F FEG SEM • AFM (Veeco CP-II), STM (NT-MDT) • Stylus profilometer model XP-2 of Ambios Technology **Testing equipment** • Systems for testing of gas flow, gas pressure, acceleration, humidity sensors, biosensors and systems, microfluidics testing etc. **Modeling and simulation software** • SILVACO tools for process and device modeling (Athina and Atlas) • Suprem and Pisces • Floops and Floods • Synopsis – Coventorware • FEMlab • Mentor graphics	**Characterization of Dielectrics** • Admittance measurements (1Hz up to 1MHz, 25-150°C) • I-V measurements (2 up to 4-terminal devices, 25-150°C) • Charge-to-breakdown measurements • Bias-Temperature-Stress measurements **Characterization of MIS Devices** • Admittance measurements (1Hz up to 1MHz, 25-150°C) • I-V measurements (2 up to 4-terminal devices, 25-150°C) • Hot-carrier stress measurements • Bias-Temperature-Stress measurements **EEPROM device characterization and reliability measurements** **Characterization of RF components** **Optical characterization** • Absorption measurements, wavelength range UV-VIS-IR • Photoluminescence (PL) • Laser excitation: 325 nm, 457.8nm, 488nm, 514.5nm • Spectrometer: 350nm-1600nm • Electroluminescence (EL): 350nm-1600nm • Photocurrent-photovoltage (UV-VIS) • FTIR **Characterterization of sensors** • Gas sensors • Microflow sensors • Accelerometers • Optical devices • Biosensors • Microfluidics **Modeling and simulation** • Process and device modeling • RF modeling

Name of the organization			
Organization Legal name		***Tyndall National Institute, University College Cork***	
Organization Short name		***Tyndall National Institute***	
Partner number		***19***	
Department/Faculty/Institute/Laboratory name		***Silicon Research Grop***	
Internet homepage		***http://www.tyndall.ie/***	
Contact person for additional information			
Name: Colinge	***First name: Jean-Pierre***	***Title: Prof.***	***E-mail address: jean-pierre.colinge@tyndall.ie***
Brief description of your organization			
The Tyndall National Institute (Tyndall) was created in 2004 at the initiative of the Department of Enterprise Trade and Employment and University College Cork (UCC) to bring together complementary activities in photonics, electronics and networking research at the National Microelectronics Research Centre (NMRC), several UCC academic departments and Cork Institute of Technology (CIT). The objective is to create a research institute, which would become a focal point of Information and Communications Technology (ICT) in Ireland, to support industry and academia nationally and to increase the number of qualified graduate students for the 'knowledge economy'. The strengths of the institute at the present time lie in the area of photonics, electronics, materials and nanotechnologies and their applications for life sciences, communications, power electronics and other industries. Research programmes range from theoretical modelling and design to novel material, nanotechnology, device processing and fabrication, packaging and integration; and novel systems incorporating these new devices.			

PROCESSING

Equipment	Techniques/competences
• Silicon clean room • e-beam lithography, optical lithography • ALD cluster	• General silicon processing • MEMS

CHARACTERIZATION & MODELLING

Equipment	Techniques/competences
• 3 cascade probes, DC to 100GHz, 4.2K to 300C • Raman, FTIR, SEM, TEM • 300-CPU cluster	• Gate dielectric in-depth characterisation • Ab-initio atomistic modelling

Name of the organization	
Organization Legal name	***Warsaw University of Technology***
Organization Short name	***WUT***
Partner number	***20***
Department/Faculty/Institute/Laboratory name	***IMiO***
Internet homepage	***www.imio.pw.edu.pl***

Contact person for additional information			
Name: Romuald	***First name: Beck***	***Title: Prof.***	***E-mail address: r.beck@imio.pw.edu.pl***

Brief description of your organization
Institute of Microelectronics and Optoelectronics is a part of the Faculty of Electronics and Information Technology of WUT. We are involved in both education (undergraduate, graduate and Ph.D. studies in the area of Electronics and Information Technology) and research (processing, modeling and characterization of semiconductor devices). We have at our disposal a clean-room (silicon compatible test structure manufacturing) and a characterization lab (I-V, C-V and CP measurements). *Our contribution consists mainly in comprehensive characterization of capacitor, gated diode and transistor structures by C-V, I-V and charge pumping measurements. We want to concentrate on the studies of the following parameters: mobility, generation lifetime and surface generation/recombination velocity (gated diode), interface properties (especially by means of charge pumping), gate leakage (tunnelling).* *The second field of WUT's expertise is modelling of MOS/SOI structures. The activity in this field within Nanosil in concentrated on lateral transport between the source and drain and the vertical transport through the high-K gate stacks.*

PROCESSING

Equipment	Techniques/competences
• Complete MOS test structure manufacturing line, silicon compatible	• Ultrathin dielectric layers (SiO_2, SiON, SiN) formation in very low (<350°C) and standard high temperature processes by means of: o thermal oxidation (>800°C) o plasma oxidation (<100°C) o Ultrashallow implantation (<2nm) (<350°C) o PECVD (<350°C) • Ultrashallow (<2nm) implantation of nitrogen and fluorine • Very low thermal budget MOS test structure technology (particularly suitable for preservation of mechanical stress in the structure and thermal treatment studies)

CHARACTERIZATION & MODELLING

Equipment	Techniques/competences
• Agilent 4275A (HF-CV) • Agilent 4140B (QS-CV)	• analysis of MOSFET I-V curves (threshold voltage, subthreshold slope, DIBL, mobility,

• Agilent 4285A impedance meter • Keithley SMU236/237 (I-V) • Keithley 617 Ammeter (CP) • Unique pulse generator for CP measurements built in WUT	etc.) • standard CV (also applied to SOI MOS capacitors), gate-leakage current and reliability • analysis of the quality of the semiconductor-gate oxide interface by means of charge pumping (average interface-trap density, energy distribution of trap density) • extraction of generation parameters (surface recombination velocity, generation lifetime) by means of analysis of the electrical characteristics of gated diodes • spectroscopic ellipsometry for independent determination of layer thickness and its optical properties (with the possibility to gain information on chemical composition and physical structure of the layer) • modeling of tunnel currents through high-K gate stacks in single and double gate MOS/SOI diodes and transistors • modeling of electron mobility (drift-diffusion, relaxation time approach) in silicon structures with SiGe layers and high-K gate stacks.

Name of the organization			
Organization Legal name		***Universitat Rovira I Virgili University of Granada***	
Organization Short name		***URV/UGR***	
Partner number		***21***	
Department/Faculty/Institute/Laboratory name		***Electronics and Computer Science***	
Internet homepage		***https://sauron.etse.urv.es/DEEEA/ /angles/recerca/nephos/ http://electronica.ugr.es***	
Contact person for additional information			
Name: URV: Iñiguez UGR: Gamiz	***First name: Benjamin Francisco***	***Title: Prof. Prof.***	***E-mail address: Benjamin.iniguez@urv.cat fgamiz@ugr.es***

Brief description of your organization

The Universitat Rovira i Virgili ***(URV)*** *was created in 1991 in Tarragona (Catalonia, Spain) by the Parliament of Catalonia from the already existing university faculties and schools. The data show that the URV is not only one of the leading universities in Catalonia but also one of the leading universities in the European area for the quality of its teaching, its commitment to continuous training and the excellence of its research, development and innovation.*
The NEPHOS (Nanoelectronic and Photonic Systems) Group of the Department of Electronic, Electrical and Automatic Control Engineering, Universitat Rovira i Virgili (URV, Tarragona, Spain) is one of the NANOSIL partners. The NEPHOS group is composed of 5 Professors, one postdoc and 6 Ph D students. The main research interests of the group are:
1) Characterization and Compact Modeling of nanoscale devices: DG MOSFETs, GAA MOSFETs, FinFETs, strained Si MOSFETs,…
2) Characterization and Modelling of Organic and Polymer TFTs
3) Technology, modelling and design of 1D and 2D photonic crystals
Publications: 10/year in the field of compact modelling of advanced devices, one invited publication in IEEE TED in 2006, IET Premium Award for one paper published in IEE Proceedings: Devices, Circuits and Systems
The NEPHOS group organizes one annual workshop: the Postgraduate Student Meeting on Electronic Engineering, that takes place in URV campus every year in June, and consists of six lecturers conducted by prestigious invited researchers, and posters presented by graduate students. Regarding funded research projects, the NEPHOS Group participates in one Network of Excellence (NANOSIL), one Industry Academia Partnership and Pathway coordinated by URV (« COmpact MOdelling Network »), one European Coordinated Action (EUROSOI), four National Projects, and one Regional Project

UGR: *This research group has a long experience in the field of numerical simulation of semiconductor devices with numerous papers published in international journals and presentations in international conferences. During the last years 15 Ph.D. dissertations have been developed and 7 state-funded research projects have been carried out in addition to the participation in several European projects: EXTRA, SINANO, and EUROSOI. The research fields of the group are listed below:*
-Electron-hole transport properties in semiconductor inversion layers including quantization.
-Monte Carlo simulation of transport properties of carriers in semiconductor heterostructures.
-Analysis and modelling of ultrashort channel devices.
-Strain Silicon/SiGe heterostructures.
-Study of transport properties of carriers in Silicon Carbide and Gallium Nitride inversion layers.
-Silicon-On-Insulator devices. Simulation of ultrathin silicon devices.

CHARACTERIZATION & MODELLING

Equipment	Techniques/competences
URV: • Prober Karl Süss PM5 • Impedance Analyzer HP4192A (C-f) • Capacimeter HP4280A (C-V, C-t) • Electrometer Keithley 619 • Temperature controller (20 ^{o}C - 200 ^{o}C) • Parametric analyzer HP4145B (I-V) • Spectrograph ARC SpectraPro-150 • Variable temperature micro-probe system (80 K – 730 K) • HP 81101A 50 MHz Pulse Generator • Agilent E5062A GNA Series Network Analyzer, 300 KHz-3GHz • Rande & Schwarz FSP Spectrum Analyzer, 9KHz-3GHz • Rande & Schwarz SM300 Signal Generator 9KHz-5GHz • Software packages for device and circuit simulation: Silvaco, ADS, VHDL-A, AIM-Spice source code,… ***UGR*** • Characterization Lab for nanoelectrónico devices, including Parameter Analyzers, Probe Stations, Network Analyzers, Hall measurement and magnetoresistance setup, Oxford cryostats, • 2 Linux clusters with 8 quad-core processor nodes (Intel Xeon) • Home-made nanodevice simulators for hole and electron transport	***URV:*** • Compact modeling techniques of nanoscale MOSFETs • Device model parameter extraction techniques • RF device characterization • Competence in physics of nanoscale MOSFETs

Name of the organization Chalmers University of Technology			
Organization Legal name		***Chalmers tekniska högskola AB***	
Organization Short name		***Chalmers***	
Partner number		***22***	
Department/Faculty/Institute/Laboratory name		***Microtechnology and Nanoscience***	
Internet homepage		***www.mc2.chalmers.se***	
Contact person for additional information			
Name: Engstrom	***First name: Olof***	***Title: Prof.***	***E-mail address: olof.engstrom@mc2.chalmers.se***
Brief description of your organization			
In year 2000, Chalmers finished a new building planned for a total staff of 200 persons within the field of "microelectronics", where groups from School of Electrical and Computer Engineering and the School of Physics combined efforts in common localities under the laboratory headlines of Microwave Electronics, Photonics, Solid State Electronics, Applied Quantum Physics and Quantum Device Physics. The building is equipped with a 1200 m^2 clean room area including equipment for semiconductor device research in silicon, III-V compounds, SiC and superconductors. From start, MC2 was organized as a university research center and in 2003 when Chalmers was re-organized, it was converted to one of the Departments replacing the "Schools" within the line organization of the university. MC2 produces on the average 15 PhDs, more than 200 scientific reviewed journal papers and about the same amount of conference contributions per year. *Staff from the Institute of Electron Technology (ITE), Warsaw, will also take part in the tasks devoted to Chalmers, ITE being a third party to the grant agreement. Professor Henryk M. Przewlocki has a long experience in MOS research and especially in optical investigations by internal photoemission studies for measuring energy band offset values of the MOS system. Professor Maria Kaniewska has a long experience of deep level transient spectroscopy (DLTS). Participation of Prof. Kaniewska's group in collaboration with Chalmers would be an efficient way to achieve information about charge carrier retention times and emission rates of the quantum dots planned as elements in memory structures. (see "third parties", page 78 of the Description of Work).*			

PROCESSING

Equipment	Techniques/competences
• See www.mc2.chalmers.se •	• See above •

CHARACTERIZATION & MODELLING

Equipment	Techniques/competences
• Electrical characterization • TEM, SEM, FIB, AFM	• Capacitance frequency spectroscopy, thermally stimulated current, deep level transient spectroscopy

Name of the organization	
Organization Legal name	***Institute of Electron Technology***
Organization Short name	***ITE (subcontract from Chalmers)***
Partner number	
Department/Faculty/Institute/Laboratory name	***Dept. of characterization of nanoelectronic structures***
Internet homepage	***www.ite.waw.pl***

Contact person for additional information			
Name: Przewlocki	***First name: Henryk***	***Title: Ph.D.,D.Sc.***	***E-mail address: hmp@ite.waw.pl***

Brief description of your organization

The Institute of Electron Technology (ITE) is a major Polish research center with the primary focus on semiconductor micro- and nanotechnology. The mission of the Institute is to conduct the basic and applied research in the field of semiconductor electronics and physics in order to develop and commercialise innovative micro- and nanotechnologies and their applications in semiconductor microelectronics, optoelectronics, photonics and micromechanics.

Department of characterization of nanoelectronic structures (Z11) is a part of ITE and is a research laboratory whose efforts are concentrated on developing new measurement methods and comprehensive characterization of new generations of nanoelectronic structures. Theoretical backgrounds (physical models) are worked out for these methods and new photoelectric, electrical and optical measurement techniques are introduced and applied. Z11 conducts comprehensive characterization of structures developed in a number of leading scientific centers in Europe, USA and Japan.

CHARACTERIZATION & MODELLING

Equipment	Techniques/competences
• Multitasking system for photoelectric measurements and analysis (original Polish design) • System for light pulse technique (LPT) and scanning light pulse technique (SLPT) measurements and analysis (original Polish design) • System for photoelectric measurements of MOS structures (original Polish design) • Agilent 4294A impedance meter • Agilent B1500A semiconductor analyzer • SSM 450i measurement and analysis system • Keithley PKG 82 measurement and analysis system • J.A. Woollam VASE spectroscopic ellipsometer • MonoVista micro-Raman spectrometer	• In addition to classical measurement methods, a number of original photoelectric measurement methods have been developed in our department, allowing in particular to determine the details of energy band diagram of structures under investigation (barrier heights, effective contact potential difference, flat band voltage, trap parameters etc.) • Standard measurements of C(V), I(V), G(V) characteristics of high resolution and sensitivity and application of the Gp/w=f(w) method. Determination of equivalent circuits. Application of multi-parameter admittance spectroscopy (MPAS). Standard and non-standard measurements of MOS capacitors/ transistors/ Schottky diodes • Determination of optical parameters and thicknesses of various layers in nanoelectronic structures. Determination of mechanical stress distribution and chemical content distribution in various structures

Name of the organization			
Organization Legal name		***Ecole Polytechnique Fédérale de Lausanne***	
Organization Short name		***EPFL***	
Partner number		***23***	
Department/Faculty/Institute/Laboratory name		***STI/IEL/NANOLAB***	
Internet homepage		***nanolab.epfl.ch***	
Contact person for additional information			
Name: Ionescu	***First name: Adrian***	***Title: Prof.***	***E-mail address: Adrian.Ionescu@epfl.ch***
Brief description of your organization			
EPFL is one of the two écoles polytechniques fédérales in Switzerland. It has three missions: education, research and technology transfer at the highest international level. Associated with several specialised research institutes, the two EPFs form the EPF domain, which is directly dependent on the Federal Department of Home Affairs *The Nanoelectronic Devices group (NANOLAB) is part of the Institute of Electrical Engineering of EPFL. The lab is working on various subjects in the field of silicon micro/nano-electronics with special emphasis on the technology, design and modelling of nanoscale solid-state devices (including Silicon-On-Insulator devices, few-electron devices, hybrid SET/CMOS, single electron memory, nanowires and nanotubes), Radio Frequency MEMS devices for in- and above-IC and integrated optoelectronic devices.* *The group is interested in exploring new materials, novel fabrication techniques, and novel device concepts for future nanoelectronic systems.*			

PROCESSING

Equipment	Techniques/competences
• Access to fabrication facilities of the Center of Micro/nano-technology of EPFL. For a detailed list of equipments see: http://cmi.epfl.ch/	• Silicon technology • MEMS/NEMS processing • Nanoscale fabrication

CHARACTERIZATION & MODELLING

Equipment	Techniques/competences
• PMC 150 • Cascade probe station • Parameter analyzers • S-parameter analyzers	• Low current characterization • Low temperature (down to 4K) electrical characterization • MEMS characterization

Name of the organization	
Organization Legal name	***Swiss Federal Institute of Technology***
Organization Short name	***ETHZ***
Partner number	***24***
Department/Faculty/Institute/Laboratory name	***Integrated Systems Laboratory***
Internet homepage	

Contact person for additional information			
Name: Schenk	***First name: Andreas***	***Title: Prof.***	***E-mail address: schenk@iis.ee.ethz.ch***

Brief description of your organization
The Integrated Systems Laboratory is a research and education unit in the Department of Information Technology and Electrical Engineering of the Swiss Federal Institute of Technology Zurich (ETH Zurich). The research and education area of the Integrated Systems Laboratory (IIS) is microelectronics, optoelectronics and nanotechnologies in general as an interdisciplinary field between electrical engineering and physics. The scientific work includes analysis, design and test of integrated circuits, theory, numerical modeling and physical characterization of semiconductor technologies and devices, and furthermore analysis and simulations of bio-electromagnetic systems. The research activities are within research projects of the European Union, and the Swiss funding agencies such as KTI or SNF and within scientific cooperations with industry in Switzerland, Europe and overseas.

CHARACTERIZATION & MODELLING

Equipment	Techniques/competences
• computer cluster •	• device physics, device modeling and simulation, numerical techniques

Name of the organization			
Organization Legal name		***SYNOPSYS Switzerland LLC***	
Organization Short name		***SNPS***	
Partner number		***25***	
Department/Faculty/Institute/Laboratory name		***CH10***	
Internet homepage		***http://www.synopsys.com***	
Contact person for additional information			
Name: Bufler	***First name: Fabian***	***Title: Dr.***	***E-mail address: bufler@synopsys.com***
Brief description of your organization			
Synopsys is the leading TCAD vendor with a tool suite covering all aspects of stress, process and device simulation, in particular also Monte Carlo device simulation. It has participated in the previous SINANO NoE on the topic of Monte Carlo device simulation. Recent publications: 1) F. M. Bufler, R. Gautschi and A. Erlebach, EDL 29, 369 (2008); 2) F. M. Bufler, A. Tsibizov and A. Erlebach, EDL 27, 992 (2006); 3) F. M. Bufler and A. Erlebach, Proc. ESSDERC, p. 174 (Montreux, 2006)			

Name of the organization			
Organization Legal name		***The University of Glasgow***	
Organization Short name		***GU***	
Partner number		***26***	
Department/Faculty/Institute/Laboratory name		***Device Modeling Group***	
Internet homepage		***http://www.elec.gla.ac.uk/groups/dev_mod/***	
Contact person for additional information			
Name: Asenov	***First name: Asen***	***Title: Prof***	***E-mail address: A.Asenov@elec.gla.ac.uk***
Brief description of your organization			
The Glasgow Device Modeling Group (http://www.elec.gla.ac.uk/groups/dev_mod/) is perhaps the largest university based specialized device modeling groups in the world including 3 academics, 2 EPSRC advanced research fellows, 10 postdoctoral researchers and 11 PhD students. It operates a 356 processing units cluster and a 32 processor IBM p690 SMP system and has privileged access to > 1000 processors on ScotGrid. Currently active research funding exceeds €8M.			

CHARACTERIZATION & MODELLING

Equipment	Techniques/competences
• 356 processing units cluster • 32 processor IBM p690 SMP system • Access to > 1000 processors on ScotGrid	• In house 3D drift-diffusion, Monte Carlo and NEGF simulators • World leader in simulation of statistical variability • Statistical compact modeling • Grid simulation technology

Name of the organization			
Organization Legal name		***University of Liverpool***	
Organization Short name		***LIVUNI***	
Partner number		***27***	
Department/Faculty/Institute/Laboratory name		***Electrical Engineering & Electronics***	
Internet homepage		***http://www.liv.ac.uk/***	
Contact person for additional information			
Name: Hall	***First name: Steve***	***Title: Professor***	***E-mail address: s.hall@liv.ac.uk***
Brief description of your organization			
The University of Liverpool is one of the UK's leading universities and plays a key role in economic development in terms of employment, skills, research and technology. Currently the University has over 19,000 registered students and an annual income of £219 million, which includes £75 million for research. *The department of Electrical Engineering and Electronics is renowned for its excellence in research and a rating of 5A was awarded to the department in the last assessment exercise. At any one time there are on average over 100 students studying at PhD, MPhil and MSc (Eng) levels in the department.* *The Solid State Electronics Research group operates in the new Wolfson and BioMEMS laboratories, which are located in 800 sqm of mainly class-100 clean room environment. The group focuses on the design, fabrication, testing, measurement, analysis and modelling of micro/nano structures and devices that integrate silicon and related materials.*			

PROCESSING

Equipment	Techniques/competences
• ALCVD Aixtron 200FE reactor	• ALD/CVD thin film growth; 2 inch wafer capacity; accurate thickness control.
• Edwards E306A Coating System	• Metal evaporation; fitted with digital thickness monitor.
• Anneal System	• Forming gas anneal; can process multi wafers.

CHARACTERIZATION & MODELLING

Equipment	Techniques/competences
• M2000U VASE™ Spectro ellipsometry + INSTEC™ Heat stage + Mapping Stage	• Multi-angle Spectro ellipsometry; Investigate: film thickness, optical dielectric constants, optical band gap, absorption coefficient and film uniformity; High resolution of 190nm to 1700nm; In-situ annealing analysis (-160 to 600 ^{o}C)
• HP 4192A impedance analyzer + Keithley 595 quasi-static CV meter	• High/low frequency capacitance voltage measurement; Investigates: equivalent oxide thickness, oxide charge density, interface states density.
• Keithley 602 Solid State Eletrometer + Heat Stage + Signatone™ Microprocessor controller	• Current voltage measurement; Investigates: activation energy, dielectric constant, Arrhenius plot; Ability to heat a wafer to a temperature from 15 ^{o}C to 300

	^{o}C; Precise control of temperature – within ± 1 ^{o}C
• HP 4155 Semiconductor Parameter Analyser + Booton 73B capacitance meter	• Capacitance transient measurement, constant voltage stress, transistor characterization; Fast data acquisition (50 μs); investigate: minority carrier lifetime, oxide charge trapping dynamics.
• Silvaco Atlas Athena Devedit simulation package	• Numerical 2D/3D Device simulation; mixed mode simulation; process simulation; able to extract DC and RF parameters.
Other possible facilities: • Transmission and Scanning Transmission Electron Microscopy (NW STEM and SuperSTEM) • X-ray photoelectron spectroscopy (ESCALab) • X-ray diffraction and X-ray reflectivity (XRR) • Medium Energy Ion Scattering (STFC Daresbury Laboratory)	• High resolution imaging, electron energy loss and energy dispersive X-ray analysis for elemental distributions

Name of the organization			
Organization Legal name		***University of Newcastle upon Tyne***	
Organization Short name		***UNEW***	
Partner number		***28***	
Department/Faculty/Institute/Laboratory name		***Electrical, Electronic and Computer Engineering***	
Internet homepage		***www.ncl.ac.uk***	
Contact person for additional information			
Name: Olsen	***First name: Sarah***	***Title: Dr***	***E-mail address: sarah.olsen@ncl.ac.uk***
Brief description of your organization			
Newcastle University traces its origins to 1834. It has 4500 staff and 17000 students. The Nano-Materials and Electronics Group is well known for its expertise in: strained Si/SiGe technology for high speed low power integrated circuits; reliability of IC interconnects; SiC for high temperature high power electronics; nanoscale electrical and physical characterization; high-k dielectrics; fabrication; technology CAD; defect engineering and diffusion; microsystems and sensors; nanotechnology			

PROCESSING

Equipment	Techniques/competences
• More than 200 m^2 of fabrication space including 20 m^2 Class 100 and 100 m^2 Class 1000/10000 clean rooms • Processing cluster from Oxford Instruments including Plasmalab System 400 magnetron sputter and FlexAL plasma-assisted atomic layer deposition (ALD) tool for ALD and sputter deposition on 8" substrates; ALD module can be configured for thermal or plasma-assisted deposition of a wide range of oxide and nitride materials • JetFirst bench top rapid thermal processing (RTP) processor for oxidation and annealing wafers up to 200 mm in vacuum and various gases • Plasma-Therm 790 series reactive ion etching (RIE) machine for processing wafers up to 200 mm • JIPELEC RTP furnace specified for SiC post-implantation annealing at temperatures up to 2000°C • Two furnaces for oxidation in nitric oxide, dry and wet oxygen • Edwards coating systems with thermal and e-beam target evaporating • Two class 100 vertical laminar flow workstations with extraction for wet chemical processing • Contact photolithography tools and	• Deposition and rapid thermal processing of thin metal films for formation of intermetallic compounds and silicides. • Fabrication of ohmic and Schottky contacts on silicon carbide • Local implantation in patterned silicon and silicon carbide • Post-implantation structure and surface recovery of silicon carbide • Oxidation and deposition of high-k dielectrics on silicon and silicon carbide • RIE patterning of silicon, silicon oxide and silicon carbide

equipment	

CHARACTERIZATION & MODELLING

Equipment	Techniques/competences
• Climate controlled characterization facilities • nm resolution Raman spectroscopy, including TERS and thermal measurements • Combined AFM (resolution>0.01nm)/Raman (resolution>20MPa) mapping • Conductive AFM, SCM • Differential Hall • Ellipsometry • 4155C Parameter Analyzer with 41501B Pulse Generator extension • 4294A LCR Bridge • Thermal chuck attached to probe station • TCAD and computational modeling • Finite element strain modeling • Accurate defect etching • E8361A PNA Network Analyzer	• Sub-nm depth profiling of strain and composition (Si, SiGe) • Nanoscale strain measurements using TERS with complementary finite element modeling • Simultaneous evaluation of surface roughness, strain and related defects • Real-time monitoring of strain/morphology evolution on a nanoscale during thermal processing • Determining thin epitaxial layer thickness and composition • Defect identification: misfit dislocations, stacking faults and threading dislocations • Sub-nm depth profiling for doping/mobility data in Si and strained Si • TCAD modeling and simulation for validation of device performance • Ab initio modelling– defects, diffusion, band structure of heavily doped Si, solubility of dopants • KLMC – extension of length and time scales; dynamical effects • Analytical gate leakage modeling • High and low frequency noise measurements • Techniques to eliminate the impact of leakage in C-V analysis of advanced gate stacks, • Conventional I-V and C-V analysis • Interface trap density, conductance technique 3 level charge pumping • AC conductance measurements for self heating analysis • Split CV for determining channel mobility • Electrical characterization at elevated temperature

Name of the organization			
Organization Legal name		***SiNANO Institute***	
Organization Short name		***SiNANO***	
Partner number		***29***	
Department/Faculty/Institute/Laboratory name			
Internet homepage		***http://www.sinano.org***	
Contact person for additional information			
Name: • ***Balestra (Director)*** • ***Caulier***	***First name:*** ***Francis*** ***Pascale***	***Title:***	***E-mail address:*** ***balestra@minatec.inpg.fr*** ***caulierp@minatec.grenoble-inp.fr***
Brief description of your organization			

The SiNANO Institute has been created in January 2008. It gathers 18 European universities, research centres, all former members of the Sinano Network of Excellence (2004-2007) in order to form a distributed Centre of Excellence in the nanoelectronic field.

It is a non profit organisation that aims to:

a) Promote and coordinate research in the area of nanoelectronic devices and technologies; promote the strengthening of the European scientific culture, technical knowledge and skills in the field, and exploit the synergies deriving from the complementary nature of the competencies available at the Association Members;

b) Encourage collaboration between associated members, research bodies, and industries.

c) Perform training activities, University curricula, Workshops to develop high competence levels in Europe, Play an important role in European structuring and programs, and strengthen the overall efficiency of the European research in Nanoelectronics.