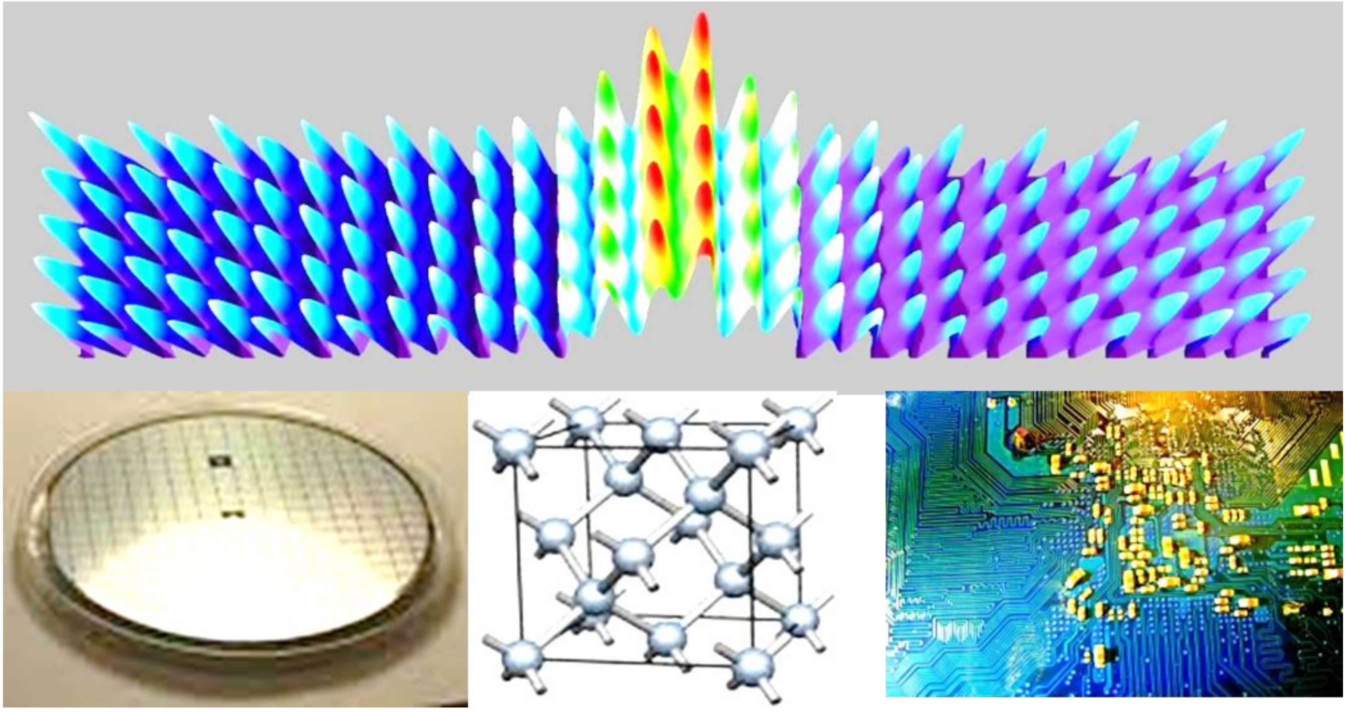
7th International Conference

Micro & Nano 2018

Thessaloniki 5-7 November 2018

Aristotle University of Thessaloniki



Book of Abstracts

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Welcome message

Dear Colleagues, Fellow Scientists,

The Organizing Committee would like to welcome you at the International Conference “Micro & Nano 2018“. This is the 7th of a series of Conferences on **Micro - Nanoelectronics, Nanotechnologies and MEMs** held in Greece every 3 years and organized by the "Micro & Nano" Scientific Society.

Serving the overall goal of the **"Micro & Nano" Scientific Society**, the Conference aims at gathering together in an interactive forum all scientists and engineers working in the challenging field of Micro - Nanoelectronics, Nanotechnologies and MEMs and to stimulate discussions in last achievements and new developments in this rapidly evolving field. One of the key objectives of the Conference is to promote collaboration and partnership between different **academia**, **research** and **industry** players in the field. The Conference combines an extensive scientific programme including oral and poster sessions and social events.

Selected papers will be published in a **special issue of Microelectronic Engineering**, after peer review. Extended abstracts of all accepted papers will be published by a well-recognized publisher, due to be announced soon.

We are looking forward to welcoming you in Thessaloniki - Greece.

Best regards,

The Organizing Committee

Monday November 5th

9:00 **Welcome**

Conference Chairpersons: D. Tassis, N. Konofaos

9:15 **Welcome by the Micro&Nano Society - Greece**

President: E. Gogolides

9:30 **Plenary Talk**

3D-monolithic integration for CMOS and post-CMOS applications

F. Andrieu*, P. Batude, L. Brunet, C. Fenouillet-Béranger, D. Lattard, M. Vinet

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Memories are already integrated in 3D, either at the device-level in the case of 3D-NAND flash or at the block-level for emerging 3D-DRAMs. For CMOS technology also, 3D integration would enable improving performance as well as pursuing the primary purpose of the Moore's law: the die cost reduction. In this context, 3D-monolithic integration is an attractive solution. 3D-monolithic integration, also named 3D sequential, consists in stacking active device layers on top of each other in a sequential manner on an only wafer substrate. It offers unique 3D connectivity opportunities: as the top active patterning is defined by state-of-the-art lithography, the misalignment and feature size of the inter-tier connections (Monolithic Inter-tier Vias) are as small as the contact ones. In this presentation, the main opportunities and challenges related to the 3D-monolithic integration for CMOS devices and digital circuits will be reviewed. Simulation results show that 3D monolithic integration can provide up to 30% power reduction at iso-performance and 30% manufacturing cost saving for digital circuits, compared to planar technology, making it an attractive alternative to the straightforward technology scaling. On top of that, new opportunities and functionalities are offered, like an efficient dynamic back-biasing capability on Fully-Depleted Silicon-On-Insulatorintegrated in 3D, for example. Finally, 3D monolithic not only addresses CMOS but also post-CMOS applications. Especially the 3D monolithic co-integration of logic and non-volatile memory devices at fine grain would open the way for new high-density, low-power memories and disruptive computing paradigms like In-Memory-Computing

10:20-11:50 Micro & Nano-electronic devices

Chair: C. Tsamis

10:20 On the Physics of Dielectric Charging in Microelectromechanical System Electrostatic Devices.

George Papaioannou

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Dielectrics play an important and, in some cases, a vital role in devices performance and reliability. In the past decade a significant knowledge has been accumulated, part of which gained from the traditional field of solid state devices, since some phenomena (e.g., dielectric breakdown or dielectric leakage) have common roots. On the other hand, aspects such as contact-surface effects that are typical of MEMS devices need to be developed from scratch. Typical architecture of MEMS devices allows for a much more versatile use of dielectric materials than in traditional CMOS devices. Dielectrics in MEMS can fill the role of sacrificial, structural, optical, masking, passivation, etch stop, insulator, and for integrated packaging encapsulation layer. The low temperature (< 300 ◦C) deposited dielectrics avoid damaging sensitive metal and polymer layers. However, the use of these films as electronic materials is challenging due to the large variation in chemical bonding that occurs in the as-deposited films and the charge-trapping centers, which spatial and energy distribution is largely unknown since they strongly depend on the material deposition conditions. Due to these the dielectric films are susceptible to charging/polarization, which may arise from dipole orientation, mobile ion and/or intrinsic free charge migration and charge injection as well as the presence of interfaces in the case of multilayer films. Taking these into account the present work aims to provide a clearer view on the charging and discharging mechanisms of dielectric films used in MEMS. The commonly used electrical characterization methods and corresponding devices are discussed. The role of temperature is also considered in order to determine the charge dynamics. Finally, the impact of covalent and ionic bond presence and its possible impact on charging is also discussed.

M1

10:50 Electrical characterization of alumina in MIM and MIS capacitor structures

E. Hourdakis*[1], M. Koutsoureli[2], G. Papaioannou[2], A. G. Nassiopoulou[1]

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Aluminum oxide (alumina) is a high-k material with a wide range of applications in the microelectronics field. The interest in this material was initially brought forward (as was the case with most high-k materials) by the need to create more efficient gating in field effect transistors but has also gained attention recently in applications such as in Metal-Insulator-Metal (MIM) and Metal-insulator-Semiconductor (MIS) capacitors for RF circuitry and energy storage, charge-trapping memory devices and passivation layers for Si-based solar cells, to name a few. The advantages of alumina are its compatibility with most CMOS materials and processes, its ability to be deposited by several methods or be formed electrochemically, thus reducing cost, and its excellent electrical properties, namely its low leakage current at small thicknesses. A careful characterization of alumina electrical properties is essential in the ability to better design its use in all of the aforementioned applications, or to define new ones. In this work we report on the electrical characterization of barrier-type anodic, sputtered and ALD-deposited alumina in MIM structures. Very low leakage current is demonstrated for anodic alumina with thickness down to 5nm, revealing the appearance of Fowler-Nordheim type field emission above a certain electric field. We also show significant charging (~2×10^{18}states/cm^3) and discharging times (as high as 5×10^{9}s), depending on the nature of metal/alumina top interface. In the case of the deposited

alumina we show that the nature of the interfaces in combination with the very small leakage current lead to the appearance of negative differential resistance (NDR) which solely depends on the population and de-population of interface traps, an effect reported for the first time in the literature.

11:10 Enhancement of responsivity of a ZnO/Si heterojunction formed on laser-microstructured Si substrates

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The most promising transparent conductive oxide (TCO) for optoelectronic applications such as ultra-violet detectors, light emitting diodes and solar cells is zinc oxide (ZnO). This is due to its large direct band gap (3.37 eV) and large exciton binding energy (60 meV) at room temperature. Silicon (Si) on the other hand is the material which is mostly or even exclusively used in microelectronics industry and in many optoelectronic applications mainly for detection and photovoltaics. Besides Si has a band gap of 1.1 eV and thus one would expect that developing wide band gap metal oxides on Si could firstly integrate ultra-violet optoelectronics in the existing Si technology and secondly broaden the spectral response of the devices towards UV. ZnO-Si heterojunctions is a suitable scenario for the realization of such ideas. In this study we developed a ZnO-Si heterojunction and we went one step farther to increase the responsivity of such a device by growing the ZnO film on a laser-microstructured Si substrate as this can increase the absorption and the active area of the heterojunction in comparison to a flat Si substrate. Si microstructuring was performed by pulsed laser irradiation in SF_6. ZnO was deposited by ALD forming with the p-type Si substrate a p-n heterojunction. Aluminum was deposited to form the electrodes. I-V characteristics showed rectifying behavior for the flat ZnO/Si device. Both flat and microstructured devices showed photoconductivity with broader spectral dependence than a Si-based p-n junction confirming the role of the wider band gap of ZnO. Specifically, photoconductivity showed three distinctive spectral regions due to transitions involving Si, electronic states within the energy band gap of ZnO and band to band in ZnO. Most importantly, a considerable enhancement in responsivity was observed in the case of the microstructured ZnO/Si device. In the present study we try to explain these optoelectronic properties.

11:30 The reductive action of Al on Al_2O_3 layers and its influence on the interface trap properties of $Al/Al_2O_3/Ge$ MIS structures

V. Ioannou-Sougleridis[1*], K. Mergia[2], S. Ladas[3], N.Z. Vouroutzis[4], A. Zeniou[1,5], S. Alafakis[5] and D. Skarlatos[5]

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In this work we investigate the influence of Al/Al_2O_3 chemical reaction on the Al_2O_3/Ge interface trap properties. Previous studies showed quite clearly that the interface trap density of $Al/Al_2O_3/Ge$ can be reduced by forming gas annealing (FGA) especially near the valence band, while the Pt/Al_2O_3/p-Ge Dit's are rather insensitive to FGA process. These facts indicate that the Al/Al_2O_3 interface and the reductive action of Al on the Al_2O_3 alters the Al_2O_3/Ge interface and as a result hydrogen can passivate interface traps located near the valence band edge.
The Al reductive action on Al_2O_3 is studied by means of TEM, XRR, XPS, spectroscopic ellipsometry and capacitance-voltage characteristics. Aluminum films of various thicknesses were

deposited on 5 nm Al_2O_3 ALD layers. The results indicate that the main action of Al on Al_2O_3 occurs upon deposition, while subsequent low temperature sintering processes do not influence substantially the reductive action of Al. The reduction of the interface traps near the valence band can be attributed to the formation of a rather ultra-thin AlGeO interfacial layer.

12:00 **Announcements by the Micro&Nano Society - Greece**

E. Gogolides, G. Konstantinides, S. gardelis, M. Bucher, F. Farmakis, D. Tassis, N. Konofaos

12:15 **Announcements by the INNOVATION.EL: A National Infrastructure in Nanotechnology, Advanced Materials and Micro/Nanoelectronics**

C. Tsamis, Institute of Nanoscience and Nanotechnology, NCSR "Demokritos"

12:30-13:30 ## Concepts, modeling and techniques

Chair: S. Stavrinides

M2

12:30 Advanced aerogel processing: A novel nanotechnology concept

K. Papachristopoulou[*1], B. Mills[2], D.J. Heath[2], R.W. Eason[2], M. Prassas[3] and N.A. Vainos[1]

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High porosity oxide aerogel materials exhibit large specific surface area and fascinating physical properties. The fractal structure of the solid skeleton results in extremely low weight, low thermal conductivity and sound velocity. Moreover, they have the capacity of isotropic sintering via viscous flow of the skeletal material, which results in a 3-dimensional reduction and solidification, at the same time maintaining the original stereometric form of the aerogel prototype. A novel platform for microstructure and nanostructure fabrication is thus realized, having an inherent built-in potential to advance the state beyond the limits of the currently available nanotechnology. This novel route presented enables minimization of solid forms and patterns made via laser ablative micro-processing by 3-dimensional contraction. Aerogel monoliths and laser written patterns are used and embedded void structures undergo contraction larger than the nominal stereometric scaling to form sub-micron channels in the solid silica. The paper describes original developments of aerogel processing and extends beyond to xerogels and other applications. Experimental results provide clear evidence of the capacities and demonstrate a generic principle that enables fundamental physical resolution limitations to be surpassed, driving to new avenues in micro- and nano-fabrication.

Acknowledgments: The support of ESPA-EPANEK National Research Infrastructures project "HELLAS-CH" (MIS: 5002735) is gratefully acknowledged.

12:50 Deep learning nanometrology

<u>V. Constantoudis</u>[1,3], H. Papageorgiou[4], E. Giannatou[4], A. Stellas[1], G. Giannakopoulos[5], G. Papavieros[1,2,3] and E. Gogolides[1,3]

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In recent years, we have witnessed the technological revolutions of Artificial Intelligence (AI) including Machine and Deep Learning (ML and DL) and Nanotechnology including Nanoelectronics. Despite the apparent different applications and targets, the exciting results of AI have been mainly fuelled by the widespread availability of increased compute power provided by the tremendous progress in semiconductor nanomanufacturing. Also, the recent growth of semiconductor market has been driven by a diverse array of applications in AI coming from the need for better and faster connectivity and more intelligent data analysis. However, besides the new types of chips that AI applications require from semiconductor chip makers and the subsequent boost of the latter, AI has started to bring also important improvements to the semiconductor and nanomanufacturing process enabling more efficient handling of obtained measurement data and better inferences and decision making. The main objective of this presentation is first to present a brief overview of the recent upsurge of the above-mentioned AI-driven improvements in semiconductor manufacturing and nanotechnology including defect identification and clustering, microscope image classification, inline semiconductor metrology, nanomaterials categorization and other applications. Then we will concentrate on two specific applications of machine/deep learning techniques in nanometrology and

nanocharacterization. The first regards deep learning techniques aiming at the accurate measurement of Line Edge Roughness using noisy SEM images acquired with few scanning frames avoiding specimen damage. In the second application, DL is used to infer predictions for the strength of the links between the parameters of the geometrical characteristics of complex nanostructured surfaces and their functional properties such as their active area controlling the wetting and catalytic behaviour of surfaces. Finally, we will summarise our talk paying special emphasis on the main prospects and challenges of DL nanomanufacturing.

13:10 High optical quality cellulose films grown by deep ultraviolet laser ablation of natural raw cotton and processed alike

V. Karoutsos[1], P. Raptis[1], E. Bagiokis[1], A. Lorusso[2], A. Perrone[2] and N.A. Vainos[1]

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The increasing need for advanced noninvasive technologies in life sciences brings about significant international interest for biocompatible materials in photonics applications. Along this line, the provision of versatile fabrication tools is of prime importance. In this work we grow and process high optical quality cellulose thin films for photonics, using raw natural cotton harvested in Thessaly, Central Greece. Pulsed laser deposition using 193 nm ArF laser pulses at very low fluence levels of ~5mJ/cm^2 produces high durability fully transparent in the visible and near-infrared materials. Standard pulsed laser deposition conditions at room temperature apply. Films deposited at close to the ablation threshold fluence values are amorphous and exhibit surface roughness better than 2 nm rms. Thin film quality and surface morphology are parametrically investigated and show a strong dependence on laser fluence. Furthermore, focused deep ultraviolet radiation is also used for micropatterning of the cellulose films yielding waveguide-like and grating structures as paradigms for future developments.

14:50-16:20 Nano-Bio-systems

Chair: A. Hatzopoulos

M3

14:50 Development of a portable diagnostic device for the detection of protein biomarkers

C. Avdimiotis[1], A. Pappas[1], L. Tzounis[1], G. Katsipis[2], A. Pantazaki[2] and G. Litsardakis[1,*]

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The electronic interface of a portable, low-cost diagnostic medical device for the rapid detection and quantification of protein biomarkers, based on disposable single walled carbon nanotube (SWCNT) resistive electrode immuno-sensors is developed. The system design is based on dc resistance or impedance spectroscopy measurement, while results are reported for the detection of Glial Fibrillary Acidic Protein (GFAP), a protein found in cells of the human central nervous system and in biological fluids. High levels of GFAP in biological fluids are known to be associated with hemorrhagic stroke events, traumatic brain injury and other neurological conditions, such as Alzheimer's disease. A linear response of the fractional resistance change (ΔR/Ro) of the bio-functionalized SWCNT electrode with GFAP concentration has been monitored by bench instruments. Then a hand-held device has been developed, that displays the measurement readout directly in units of the analyte's concentration. The device is not limited to GFAP detection, since the chemical modification performed on SWCNT deposited films, in order to accommodate the anti-GFAP polyclonal antibody and create the GFAP specific biosensor, can also be adapted to effectively attach other antibodies and fabricate the corresponding protein biosensors. The device has been designed to use electrodes bio-functionalized for different biomarkers, as the calibration curve can be selected or modified by the user. The feasibility of a versatile, portable diagnostic device based on SWCNT immune-sensor is demonstrated.

15:20 Low-cost, PCB manufacturable microdevices for fast DNA amplification

G.D. Kaprou[a,b], V. Papadopoulos[a], I. Kefala[a], G. Papadakis[c], E. Gizeli[b,c], S. Chatzandroulis[a], G. Kokkoris[a*], A. Tserepi[a*]

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The integration of nucleic acid amplification modules in microfluidic platforms is considered a highly promising and appealing approach for the development of selective, sensitive, cheap and efficient diagnostic tools for medical, food safety, environmental monitoring and forensic applications. The main challenge for successful commercialization of such microfluidic devices is scaling-up, i.e. the transfer of prototype microdevices into industrial mass production [1]. Herein both a continuous flow Polymerase Chain Reaction microdevice (μPCR) and a static chamber μdevice for isothermal DNA amplification employing the Loop Mediated Isothermal Amplification (LAMP) method are designed, fabricated and validated during the amplification of 157 bp DNA fragments corresponding to the exon 20 of the BRCA1 gene and the *Salmonella* invasion gene invA, respectively. We propose the introduction of commercially available polyimide based materials, already established and utilized in the PCB industry, nevertheless in an ultimately different role and application, for the fabrication of microfluidic devices enduring both high temperatures and high pressures during their operation. Detailed numerical calculations are performed for improved μPCR chip design from a thermal distribution point of view. The nucleic acid amplification microdevices are fully integrated with an acoustic biosensor chip employing a hybridization-free, sensitive, acoustic detection assay of double stranded DNA from complex samples, for example, for foodborne pathogen detection in milk [2]. The introduction of these PCB-

compatible materials enables the integration of microfluidics with copper resistive microheaters [3] necessary for thermal treatment of DNA in integrated microdevices, ideally suitable and easily manufacturable at large scale and low cost by existing PCB manufacturers. The addition of the acoustic sensor for label-free DNA detection offers a fully integrated lab-on-a-chip platform for rapid and sensitive DNA-based diagnosis at the point-of-care.

[1] D.I. Walsh, III, D.S. Kong, S.K. Murthy, P.A. Carr, Enabling Microfluidics: from Clean Rooms to Makerspaces, Trends in Biotechnology, 35(2017) 383-92.
[2] G. Papadakis, P. Murasova, A. Hamiot, K. Tsougeni, G. Kaprou, M. Eck, et al., Micro-nano-bio acoustic system for the detection of foodborne pathogens in real samples, Biosensors and Bioelectronics, 111(2018) 52-8.
[3] G. Kaprou, G. Papadakis, D. Papageorgiou, G. Kokkoris, V. Papadopoulos, I. Kefala, et al., Miniaturized devices for isothermal DNA amplification addressing DNA diagnostics, Microsystem Technologies, 22(2016) 1529-34.

15:40 Use of a novel graphite/SiO_2 hybrid electrode modified with hybrid organic-inorganic perovskites for the determination of losartan

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Hybrid organic-inorganic semiconductors (HOIS) have lately been reported for their exceptional optoelectronics properties that make them suitable candidates for use in the field of light emitting diodes and photovoltaics. However, recently we immobilized them successfully on mesoporous TiO_2 films for the development of a chemical sensor for CBr_4. In this work, HOIS are being used as adsorbed modifiers of a Graphite/SiO_2 hybrid film electrode (GSiHE) in order to develop a simple and efficient electrochemical sensor for the sensitive, relatively specific, determination of a strong antihypertensive drug, losartan (LOS). Losartan potassium is a white, water soluble, strong antihypertensive agent, non-peptide, and exerts its action by specific blockade of angiotensin-II receptors (LD_{50}=1000 mg/kg). The electrochemical behavior of the GSiHE film electrode modified with 3D-perovskites was examined by cyclic voltammetry (CV) while its morphology, structural and spectroscopic properties were investigated by field emission scanning electron microscopy (FE-SEM), X-ray diffraction (XRD), optical and luminescence spectroscopy. Under optimized conditions the modified film electrode demonstrated excellent electrocatalytic activity towards oxidation of LOS in the linear responses ranges from $4x10^{-5}$ M to $3.2x10^{-4}$ M, with a limit of detection (LOD) at $4.6x10^{-6}$ M. The current peaks of the modified electrode were significantly enhanced compared to a bare GSiHE due to the higher conductivity and electrochemical active surface area provided by the immobilized perovskite. The sensor takes advantage of the ability of ions to interact with the HOIS lattice on the GSiHE film. This type of sensor has demonstrated good repeatability, reproducibility and stability and was found to be applicable for use in pharmaceutical tablet samples.

16:00 Integrated, fast, cost effective, semi-automated Lab on a Chip for foodborne pathogen detection

G. Kaprou[1,2], K. Tsougeni[1,3], C.-M. Loukas[1], G. Papadakis[4], A. Hamiot[5], M. Eck[5], D. Rabus[6], G. Kokkoris[1], V. Papadopoulos[1], B. Dupuy[4], G. Jobst[5], E. Gizeli[2,4], A. Tserepi[1*], E. Gogolides[1*]

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Public health is continuously posed to serious risks by various food pathogens such as Salmonella. In order to enable efficient and rapid controls in all levels of the food chain, portable, low cost and user friendly platforms for biological hazard detection are required.
In a recent work, we have demonstrated an ultra-fast (t<4h) Lab-on-Chip for pathogen detection

involving one off-chip manual step for sample pre-treatment using immunomagnetic microparticle separation of *Salmonella* in milk. The aim of the present work is the development of an integrated, semi-automated LoC platform for fast pathogen detection in food samples. The LoC requires one off-chip manual pre-culture step and sample centrifugation / resuspension for sample concentration. The proposed platform is based on a compact microfluidic chip, combining bacteria capture and chemical lysis with DNA amplification (Loop-mediated isothermal amplification, LAMP) in a single chamber integrated with a Surface Acoustic Wave (SAW) biosensor for label free detection. Rather than using magnetic microparticles, a novel oxygen plasma nanotexturing process step is employed for highly efficient bacteria capturing following high-density antibody binding. The microfluidic chip offers operational simplicity, small footprint and cost. This work paves the way to the implementation of an integrated, cost-effective platform for rapid and label-free DNA analysis, addressing not only food safety, but also point-of-care diagnostics. The verification of the acoustic detection was performed after a short pre-culturing step, starting from 1-5 CFUs in 25ml of spiked, fresh pasteurized milk. Preculture is followed by preconcentration via centrifugation, introduction of the sample in the plastic chip for bacterial capture, lysis and DNA amplification and SAW detection. The time to answer is decreased down to less than 6h, which is at least 4-times faster compared to conventional methods used for food analysis.

The proposed platform is developed within the EU project LoveFood2Market (Contract No 687681).

16:40-18:10 Critical nanoscale phenomena

Chair: G. Vourlias

M4

16:40 On the role of Fractional Calculus and Fractal Analysis in Modeling Material Problems at Micro/Nano Scales

K. Parisis[1] and E. C. Aifantis [1-5]

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In recent years, fractional calculus and fractal analysis has gained an unprecedented attention by the applied mathematics and theoretical physics communities, since many observations for natural phenomena, as well as technological and biomedical processes, (conducted through newly developed experimental tools) could not be interpreted through conventional approaches based on standard differential calculus, equations and Euclidean geometry. These concepts and associated techniques have not found yet applications in micro/nano technology and micro/nano engineering mechanics. In this talk we provide some definite results on the use of fractional/fractal models for transport and deformation processes at micro/nano scales. Examples from fractional/fractal diffusion and elasticity are presented, generalizing classical results based on Fick's and Hooke's classical theories.

References: E.C. Aifantis, Internal Length Gradient (ILG) Material Mechanics Across Scales and Disciplines, Adv. App. Mech. **49**, 1-110, 2016.
Acknowledgments: The support of the Ministry of Education and Science of Russian Federation under Mega Grant Project "Fabrication and Study of Advanced Multi-Functional Metallic Materials with Extremely High Density of Defects" (No. 14.Z50.31.0039) to Togliatti State University is gratefully acknowledged.

17:10 Intermittency-induced criticality in the random telegraph noise of nanoscale UTBB FD-SOI MOSFETs

Y. Contoyiannis[1], S.M. Potirakis[1], S.G. Stavrinides[2,*], M.P. Hanias[3] and D.H. Tassis[4]

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The drain current in nanoscale fully depleted ultra-thin body and buried oxide n-MOSFETs is studied in terms of critical dynamics. The studied nano-device fabricated by STMicroelectronics was stressed and had a channel with W=0.5μm and L=30nm. This kind of devices are compatible to planar CMOS fabrication processes and further scaling is possible. Consequently, inherent noise study is a very important issue. In this case and under certain bias conditions drain current exhibits a complex random telegraph noise (RTN). The evaluation of the fluctuations of such an experimentally obtained RTN time series suggests a deterministic chaotic behavior for the mechanism behind this behavior; while its fractal nature has been highlighted [1]. In this brief, this drain current time series is analyzed by means of the method of critical fluctuations, in analogy to thermal critical systems. Intermittent criticality has been revealed for the specific two-trap RTN fluctuations, possibly related to the trap emission/capture process. The existence of two fixed-points in the drain current values distribution, is confronted by separation of the fluctuations in two groups, the "upper" and the "lower" one, before the application of the method of critical fluctuations to each of the corresponding sub-time series. Each one of these two sub-time series demonstrate critical characteristics, since the distribution of their laminar lengths follows power

laws, for a wide range of laminar regions with similar power-law exponents. Finally, an interpretation of the dynamics of traps is suggested within the frame of continuous phase transitions.

[1] D.H. Tassis et al, "Chaotic Behavior of Random Telegraph Noise in Nanoscale UTBB FD-SOI MOSFETs," IEEE Electron Device Letters, vol. 38, no. 4, 2017.

17:30

Hot Carrier Degradation of nanoscale Triple Gate Junctionless nanowires

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In this work, we investigate the hot carrier degradation mechanisms of n-channel junctionless nanowires with short (L = 25 nm) and long (L = 65 nm) channel lengths. The devices were electrically stressed in the most degrading bias condition in the on-state ($V_g = V_d = 1.8$ V) for stress time up to 10^4 sec. The device degradation was monitored through the evolution of the transconductance, threshold voltage, subthreshold slope, on-state current and gate current shifts with stress time. We demonstrate that the degradation mechanisms in short channel device are different from those of the long channel device. In the long channel device, the hot carrier degradation is dominated by interface state generation and charging of pre-existing gate dielectric traps under long stress time. In the short channel device, in addition to the interface state generation and charging of pre-existing gate dielectric traps, new gate dielectric traps and energy distributed interface traps are generated after long stress time due to the enhanced impact ionization rate. The degradation mechanisms are supported by low frequency noise measurements in the frequency and time domains.

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17:50

Charging properties of SiNx with embedded CNTs for MEMS capacitive switches application

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The dielectric charging is still the most common reliability issue in capacitive RF-MEMS switches that hinders their commercialization and is mainly caused by the charge injection during actuation (pull-in state). The injected and trapped charges are responsible for undesirable effects such as the shift of capacitance – voltage characteristics, narrowing of pull - in/out windows, the degradation of C_{ON}/C_{OFF} ratio and finally device failure due to bridge stiction. In the pull-out state the injected charges can only be removed via the bottom electrode. Thus, the most important parameter to increase the device lifetime is the ability of the dielectric film to quickly drain the injected and trapped charge. Among various dielectric materials proposed to mitigate the charging effect, silicon nitride (SiN) is a promising one due to low temperature (≤50°C) PECVD deposition method and high dielectric breakdown voltage. In spite of this the concentration of defects in SiN is large and the charge draining slow with time constants ranging up to more than one year in thick and almost stoichiometric films. A promising solution is the growth of nanostructured dielectrics by introducing CNT in SiN host material in order to locally increase the discharging field and accelerate discharging process while maintaining/improving the dielectric properties of the insulating film. In order to achieve this, the CNTs have to be isolated from bottom or top electrode or from both by introducing an additional dielectric film. For this, dielectric films with different structures: i) SiN/CNT bottom layer with a SiN layer on top and ii) a three-layer film consisting of SiN-SiN/CNTs-SiN. The electrical properties of MIM capacitors and MEMS capacitive switches based on these structures were assessed at different temperatures in order to determine the charge kinetics and the MEMS charging/discharging processes characteristic times.

18:20-19:50 Poster Session I

Chair: D.H. Tassis, N. Hastas

P I.1

Atomistic approach of interfacial segregation in FCC metallic alloys

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The surface-segregation in a bimetallic alloy strongly modifies the properties vis-à-vis its catalytic properties. Surface and interfacial segregation is a continuous subject of numerous studies both experimental and theoretical. In a metallic alloy, the surface energy can be lowered by changing its chemical composition: the segregation or surface enrichment in the alloying element lowers the surface energy. After studying the driving forces of segregation at the atomistic level per atomic site at surfaces and at grain boundaries, we investigate the segregation power of an atomic site when one, or several, neighbouring site(s) are already segregated. We first limit ourselves to the case of binary metallic systems such as for instance Ni(Ag). We study the typical case of the (110) surface and the Σ=11{332}<011> tilt grain boundary which has a rich variety of segregating sites. We use Embedded Atom Model potentials of the Finnis-Sinclair family specially adapted to face centred cubic metals and adapted to reproduce their intrinsic stacking fault energies. The nature of the mixed parameters between A solute atoms and B solvant atoms is fitted according to formulae developped on experimental enthalpies of mixing of A within B. Ni-Ag system has been selected because it has a large size effect and a tendency to phase separation. In the following study, the surface segregation in Ni(Ag) is characterized by an energy of segregation when a silver bulk atom is exchanged with a nickel atom of the alloy surface. Energies of segregation are calculated using a robust N-body interaction potential of the Finnis-Sinclair (EAM) in an annealed Molecular Dynamics. In this study, we examine the effects of segregation of many atoms on the surface (110) and a grain boundary the Σ=11 {332}, in order to compare the multi atomic energies of segregation to those for the monoatomic ones.

P I.2

Detection of BRCA1 on partially reduced graphene oxide biosensors.

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The development of protein and DNA detection protocols is expected to expand the application of biosensors to different aspects of human life. Efficient immobilization of proteins molecules on transducer surfaces is important for the development of biosensors. Recently, graphene materials have received increasing attention showing great promise in many applications including biosensors. In

this work, the immobilization of proteins towards the fabrication of a reduced graphene oxide (rGO) biosensor is investigated. Mild thermal treatment (90-200ºC for 1 h) in ambient air is used to progressively reduce GO drop-casted on a silicon oxide substrate, after its hydrophilization and functionalization. As a result of the reduction, the graphene sp2 lattice of GO is gradually restored and its electrical conductivity is enhanced. At the same time, rGO retains some functional groups during the course of the reduction, thus facilitating the immobilization of proteins on its surface. Biotinylated Bovine Serum Albumin (b-BSA) is used as a model molecule in protein immobilization experiments. The immobilization of b-BSA on reduced GO surfaces is verified through the reaction of biotin with streptavidin by fluorescence microscopy. Based on these results, a simple biosensor is fabricated comprising mildly reduced GO as a transduction element on Si/SiO2 substrates and silver paint contacting electrodes. First, the sensor was used to detect b-BSA immobilization with concentration as low as 260pM and down to 9nM of streptavidin during b-BSA-streptavidin interaction. Then, it was used for a medically relevant application to detect BRCA1 mutations which is linked to breast cancer. BRCA1 concentrations down to 200pM were detected.

P I.3 On the Effects of Environmental Factors on the Functionality of Modern Dynamic Random Access Memory Modules

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Modern Dynamic Random Access Memory (DRAM) modules are produced using manufacturing processes of at most some hundreds of nanometers. DRAMs are commonly based on the Complementary Metal–Oxide–Semiconductor (CMOS) technology, and their cells most often consist of a gatekeeper transistor and a storage capacitor connected to the transistor's drain. Access to the capacitor is enabled through the activation of the transistor using a word-line wire connected to the transistor's gate, while the stored logical values are read, written or refreshed as high or low voltage through a bit-line wire connected to the transistor's source. As the size of the DRAM cells becomes smaller and smaller and as modern DRAMs are produced using a very large scale integration process, external environmental factors may start to play a rather significant role on the functionality of such memory modules. For this reason, we examine, in our work, the effects of common environmental factors on the functionality of modern widely used DRAM modules that have been produced using semiconductor manufacturing processes of different sizes. In this way, we aim to determine how common environmental factor variations, such as high or low temperatures, voltage variations or the presence of radiation, may affect the functionality of modern electronics and, in particular, the performance, capabilities and characteristics of modern DRAM modules. As DRAM modules are nowadays essential components of most computer systems, we believe that it is highly important to investigate how common external environmental factor variations may affect the way these memory modules work and their characteristics. Notably, our experimental research tends to indicate that modern DRAM modules are highly affected by temperature variations, while being highly tolerant to radiation and voltage variations. Finally, based on our results, we can draw useful insights about the potential applications of modern DRAM modules in the industry.

P I.4

Quantum interference in pump-probe absorption of coupled quantum – plasmonic nanostructures: Comparison between metallic nanoparticles and carbon nanostructures

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In the last thirty years significant experimental and theoretical research work has been done in quantum coherence and interference phenomena in nonlinear optical processes that occur when coherent electromagnetic fields interact with multi-level quantum systems. Quantum coherence and interference effects have been also recently studied in the nonlinear optical response of quantum systems with plasmonic nanostructures. A quantum system that has shown remarkable optical response in that area is a four-level double-V-type quantum system that exhibits quantum interference in spontaneous emission when placed near a two-dimensional array of metal-coated dielectric nanospheres. In this quantum system, one V-type transition is influenced by the interaction with localized surface plasmons, while the other V-type transition interacts with freespace vacuum and with the external laser fields. When this system interacts with a weak probe laser field, it leads to optical transparency accompanied with slow light and strongly modified Kerr nonlinearity. Additionally, when the system interacts with two laser fields it leads to huge enhancement of the absorption at the central line, gain without inversion, and a phase-dependent absorption spectrum. Here, I present for the first-time results for the optical response of the fourlevel double-V-type quantum system near different plasmonic nanostructures that also lead to quantum interference in spontaneous emission due to the existence of surface Plasmon resonances and anisotropic Purcell effect, namely a metallic nanosphere, a single graphene monolayer and a single-wall carbon nanotube. I consider the interaction of the quantum system with two laser fields, a weak probe field and a pump field, and compare the results of the probe absorption spectrum under the influence of the pump field in the presence of the different plasmonic nanostructures.

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P I.5

Energy band profile of Al/HfO2/p-Ge MOS structures by XPS and electrical characterization

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The construction of the energy band profile of MOS structures based on high-k dielectrics and high mobility substrates is critical for the understanding and optimization of their electrical response [1,2]. It is well known that some of the crucial criteria for an alternative to SiO_2 gate dielectric include a defectless interface (atomically flat with low rms roughness) exhibiting low Density of interface traps (D_{it}), a high value of permittivity (at least higher than SiO_2) as well as a sufficient barrier height that will effectively block electrons and holes. High quality HfO_2 constitutes one of the possible alternative high-k dielectrics mainly due to its chemical stability and high permittivity value (k=20-25) [3,4]. The aim of the present work is the construction of the interface band diagrams of HfO_2/ p-Ge combining two different experimental techniques i.e. X-ray Photoelectron Spectroscopy and electrical conductivity measurements. The implementation of these two methods gives a thorough insight of the electrical behaviour of MOS structures. HfO_2/p-Ge, up to 15nm, structures were grown via Atomic Layer Deposition (ALD) technique at 250°C. The precursor, used for the deposition of HfO_2 was Tetrakis(Dymethylamido)Hafnium while the co-reactant / oxidant was water. The chemical composition as well as the energy barrier height between HfO_2 / p-Si interface were studied ex situ by XPS. Al gate electrodes were deposited onto HfO_2 films, by thermal evaporation technique, resulting in Al / 15nm HfO_2/ p-Ge MOS structures. The structures were electrically characterized through the analysis of C-V, G-V and C-f measurements in order to evaluate the density of interfacial traps (D_{it})

and the EOT value. Furthermore, J-V measurements were performed and analyzed, for both positive and negative gate voltages with temperature as a parameter. Conduction mechanisms and energy barrier heights were verified / calculated for both negative and positive electric fields.

[1] H.,Sung et al., Appl. Phys. Let. 105, 182101, (2015)
[2] Tahir et al., Applied Physics Letters 94, 212902, (2009)
[3] P. Svarnas et al. Thin Solid Films, 99, 49-53, (2016)
[4] M A Botzakaki et al. J. Phys. D: Appl. Phys., 49, 385104, (2016)

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P I.6 Electrical conductivity mechanisms and XPS analysis of Al/Ta2O5/p-Si MOS structures

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It is well known that the recent trends in Microelectronic's research focus on the possible replacement of SiO_2 with materials exhibiting inherently higher permittivities compared to that of SiO_2 [1-3]. The implementation of high-k dielectrics onto semiconducting substrates results into Metal Oxide Semiconductor (MOS) devices exhibiting simultaneously low Equivalent Oxide Thicknesses (EOT) as well as low leakage currents. Furthermore, the creation / formation of sufficient barrier heights between high-k / semiconducting substrate and metal / high-k interfaces is also crucial in order to block holes and electrons [3]. Representative high-k dielectrics are Al_2O_3 (k~9), Ta_2O_5 (k~18-20), ZrO_2 (k~20) and HfO_2 (k~20). In the present study, 7nm Ta_2O_5/ p-Si and 20nm Ta_2O_5/ p-Si structures were developed via Atomic Layer Deposition (ALD) technique at 300°C using PentakisdimethylamidoTantalum as the organic precursor and water as oxidant. The stoichiometry as well as the energy barrier height at the interface HfO_2 / p-Si were evaluated by X-ray Photoelectron Spectroscopy (XPS). From the XPS analysis, the stoichiometry of Ta_2O_5 thin films and the presence of a silicon suboxide (SiO_x) intermediate layer were verified. Furthermore, a barrier height of 0.62 eV was calculated at the Ta_2O_5/p-Si interface. High Resolution Transmission Electron Microscopy (HRTEM), reveals that Ta_2O_5 is amorphous and further on confirms the existence of an 1.0-1.5nm thickness of SiO_x. I-V measurements were performed for both negative and positive voltages as a function of temperature, revealing the prevailing conduction mechanisms. Specifically, in the low voltage region (positive and negative), the Ohmic conduction mechanism is the dominant one with an activation energy of 0.67eV. In the high positive voltage region, the Schottky conduction mechanism is dominant, with activation energy of 0.61eV while in the high negative voltage region the trap control space charge limited conduction prevails with shallow trap activation energy of 0.1eV.

[1] M. A. Botzakaki et al., J. Vac. Sci. Technol. A 36, 01A120 (2018).
[2] M A Botzakaki, J. Phys. D: Appl. Phys.49 385104 (2016).
[3] H. Jin et al., Applied Physics Letters 89, 122901, (2006).

P I.7 Influence of high-temperature annealing on the hole transport and trapping properties of Al2O3/SiO2 dielectric stacks

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In this study we examine the influence of high-temperature post deposition annealing (PDA) on the hole transport and trapping characteristics of dual dielectric Al_2O_3/SiO_2 stacks. ALD alumina films 20-25 nm thick were deposited on 3.5 nm SiO_2 thermally grown on Si substrates, using TMA and H_2O at 200 and 300 ºC. PDA was performed at 850 ºC in N_2 ambient for 15 min, where ALD alumina crystallizes and densifies. The study was performed on Pt gate electrode capacitors. The significant increase of the leakage current which is monitored after PDA in the negative bias regime is attributed to the asymmetric widening of the alumina bandgap. This triggers a change of the dominant hole injection mechanism. Before PDA direct tunneling of holes is the dominant mechanism while modified Fowler-Nordheim (MFN) can be realized after PDA. This reasoning can explain both the increase of the leakage current as well as the increased hole trapping under negative bias.

P I.8 The effect of thermal annealing on the structural and optical properties of CQD-based thin films

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Carbon-based Quantum Dots (CQDs) are the newest member in the carbon nanoparticle family. Owing to their chemical inertness, low toxicity and facile functionalization of their surface chemistry, combined with unique optical properties such as photoluminescence and resistance to photobleaching, they have attracted significant interest as candidates for various applications ranging from OLEDs to chemical sensors, bioimaging and photocatalysis. Despite their extensive research, to date, their optical properties and the underlying mechanisms have not been yet fully understood, partially due to the various synthetic routes available, which lead to different types of CQDs. In this work, a nanocomposite material consisting of N-doped CQDs and N-doped graphene strips was synthesized by microwave-assisted pyrolysis and carbonization of an aqueous mixture of citric acid and urea precursors. TEM studies revealed the end product was comprised of quasi-spherical CQDs with graphitic core, approximately 3 – 7 nm in diameter, and graphene strips of 5 – 10 graphene sheets and a length of about 25 nm. The structural as well as the optical properties of the material were studied using PL spectroscopy under three different conditions: a) in solution, b) as deposited on SiO2 substrates and c) after annealing at various temperatures. The structural properties of the nanocomposite were studied by UV-Vis, FTIR and XPS spectroscopy, revealing the existence of organic functional groups such as carbonyls, carboxyls, amines, amides and esters on the compound surface and edges and allowed us to observe changes in the predominant states of the elements comprising the material, namely Carbon, Nitrogen and Oxygen. Analysis of the results provide important information on the correlation of the optical and structural properties of the nanocomposite material as a function of the thermal annealing.

P I.9 Growth of ZnO nanowires on seeding layers deposited by Atomic Layer Deposition: The influence of process parameters

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Zinc oxide (ZnO), a wide and direct band gap (3.37 eV) semiconductor possessing high exciton binding energy of 60 meV, has been recognized as one of the promising nanomaterials in a broad range of high-technology applications in optoelectronics, photovoltaics, energy harvesting and sensors. Over the last decade extensive effort has been directed toward the growth of well-controlled crystalline ZnO nanowires synthesized by low temperature, low cost and large area hydrothermal methods. In this work we investigate the growth characteristics of ZnO nanowires on ZnO seed layers formed via Atomic Layer Deposition (ALD) method. ALD ZnO films were deposited on Si/SiO2 substrates using Savannah-100 ALD (Cambridge-Nanotech/USA) system, with diethilzinc

[(C2H5)2Zn, DEZ] and H2O as deposition precursors. The deposition temperature ranged from 80 to 250°C while the deposited film thickness ranged from 10 to 20 nm. Part of the samples were annealed in atmospheric air at 500°C for 30 min. Subsequently ZnO NRs were grown in equimolar aqueous solutions of zinc nitrate heahydrate (ZnNO3.6H2O) and hexamethylenetetramine (C6H12N4, HMTA) at 87°C. The surface roughness of as deposited and annealed ALD films is measured by Atomic Force Microscopy (AFM). ZnO nanowires were characterized by Scanning Electron Microscopy (SEM). Statistical analysis was performed to assess the size and shape distribution of the nanorods. X-ray Diffraction (XRD) analysisis used to identify the crystalline nature of the ALD seed layer as well ZnO nanowires. Our results indicate that the surface roughness as well as the thermal annealing of the ALD deposited samples influence the growth of the ZnO nanowires as well as the alignment of the nanowires. Comparison with ZnO nanowires growth on sol-gel as well as sputtered seeding layers provide useful information for the growth of ZnO nanowires.

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P I.10

Applying power contributors method for leakage currents modeling of CMOS Cells

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In the nanoscale regime the accurate prediction of the static power consumption as well as the leakage currents, early in the design cycle, is a very important task. A precharacterization procedure has to be followed in order to provide accurate models for this purpose. In general, such a procedure is very slow since many circuit states and configurations have to be tested. However, the power contributor method has been proposed in order to significantly decrease the number of precharacterization tests accelerating the corresponding procedure. This method is based on the separability of the power components. The circuit cells are decomposed into Power Contributors (basic circuit structures), and all the leakage currents which run through their terminals, are modeled in a systematic way. Then these components are comprised to provide the leakage currents and power consumption of the initial cells. The produced models are expressed as a function of the power supply voltage, temperature and the transistor width. In this paper the power contributor method has been applied for the AOI22-X1 cell of the NanGate OpenCell library for the technology node of 45nm. Results are very promising since present an average error below to 1% and a maximum error less than 2%.

P I.11

Electronic properties and magnetism of Si nanowires with non-magnetic doping and surface dangling bonds: a DFT approach

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The study of nanostructures with surface dangling bonds could be important for nanomagnets and spintronics development, as the dangling bonds provide the necessary unpaired electrons for magnetic ordering. In particular, semiconductor nanowires with surface dangling bonds can show half-metallic behaviour, as they are 100% spin-polarized at the Fermi level. This effect has been theoretically investigated in boron and phosphorous doped silicon nanowires; however, reports of other non-magnetic dopants are missing from the literature. In this work, the effect of B, Al, Ga, N, P and As doping on the electronic properties of Si nanowires with surface dangling bonds is studied through density functional theory. The ultra-thin nanowires are modelled in the [100] crystallographic direction with a diameter of about 1 nm according to the supercell scheme. Doping is made by substituting a Si atom for a dopant atom at the centre of the cross section of the nanowire, and the dangling bonds are in mutually symmetric sites on the surface. The electronic states due to the dangling bonds have significant spin-splitting, and the appearance new states from the dopant causes a shift in the energy of the bands, allowing some bands to cross the Fermi level for one of the spin channels. The ground state magnetic behaviour is highly dependent of the dopant, for instance Al-, Band P-doped nanowires are ferromagnetic, while Ga- and N-doped nanowires are antiferromagnetic. We hope that this investigation could enrich the knowledge about nanostructures with possible spintronics applications.

P I.12

Vacancies and boron doping in a zinc oxide monolayer: a DFT investigation

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Recently, stable single-atom-thick, bidimensional ZnO monolayers (ML) and nanosheets have been experimentally obtained. ZnO in its bulk phase is known as a favourable material for molecular sensors, and monolayered ZnO would increase the surface available for adsorption of molecules, allowing for a more sensitive detector. Besides, first-principles calculations have predicted remarkable electronic and magnetic properties on defected, or doped, ZnO ML. However, the concurrent effect of these two modifications has not been addressed. In this work we study the effect of simultaneous boron-doping and vacancies on the electronic properties of ZnO ML. Band structures and projected densities of states are computed through spin-polarized Density Functional Theory and analyzed. It is found that the O vacancies on the B-doped ML are more stable than Zn vacancies. The B-doped ZnO ML with Zn vacancies shows antiferromagnetic ordering, while its counterpart with O vacancies, as well as a divacancy case, have non-magnetic ground states. These results point to a potential route for the engineering of the electronic and magnetic properties of ZnO monolayers, which could be useful in fields such as chemical detection or spintronics.

P I.13

Atomic Structure Investigation of Shockley Partial Dislocations in GaN Using Aberration-Corrected HRTEM

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Determining the atomic structure of partial dislocations in III-nitrides could offer an explanation about their introduction in high densities in epilayers [1] and the reactions leading to the nucleation of threading dislocations [2]. The Shockley partial dislocations in GaN have been studied using by aberration-corrected high-resolution transmission electron microscopy (HRTEM). Energetically relaxed models of such defects, obtained from molecular dynamics and density functional theory (DFT) calculations, were used as input for extensive HRTEM image simulations. The investigation was focused on dipoles of Shockley partials separated by a stacking fault arising from the dissociation of screw **a**-type lattice dislocations along <11-20> line directions. The atomic structure of each dislocation core was determined under appropriate imaging conditions in a focal series of images. A direct visualization of atomic arrangements was inferred from the interpretation of the contrast features around each dislocation core. The crystallographic constraints imposed by the stacking sequences and the material polarity were taken into account for pre-determining admissible core structures. The atomic-scale analysis concluded to the most prominent structural models for these partial dislocations.

[1] C. Bazioti, et al., *J. Appl. Phys.* **118**, 155301 (2015).
[2] J. Smalc-Koziorowska et al., *Appl. Phys. Lett.* **108**, 051901 (2016).
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P I.14

Understanding Small Fe–Mo Perovskite-like Clusters

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Bulk Sr_2FeMoO_6 (SFMO) double perovskite is characterized by half-metallic behavior, which is tunable through the Fe/Mo ratio, the degree of antisite disorder, or the replacement of Mo atoms with other transition metals. To elucidate the differences in the energy distributions of the up- and down-spin electrons, we report the density of states (DOS) determined for the $(FeO_6)^{-4}$ and $(MoO_6)^{-6}$ octahedral clusters. To complement the energetic and geometrical information for these octahedral clusters, we also studied the $(FeO_4)^{-2}$ and $(MoO_4)^{-2}$ planar clusters. The results from our density functional theory calculations reveal that the SFMO half-metallicity is due to the Fe-centred clusters, *i.e.*, the shifting in the spin DOS arises from the decoupling of Fe t_{2g} spin orbitals, forming antibonding hybridizations with oxygen p states, which are occupied in the up-spin channel but unoccupied in the down-spin channel. The semiconducting character of the up-spin channel is due to the large energy difference between the t_{2g}^a states and the unoccupied, antibonding e_g^a, whereas the down-spin channel has metallic character because it contains the highest occupied molecular orbital (HOMO), which is near the unoccupied t_{2g}^a states. In contrast, the $(MoO_6)^{-6}$ octahedral clusters do not exhibit perovskite half-metallic character because the Mo-containing clusters have zero total spin. Finally, in contrast to the octahedral clusters, the planar $(FeO_4)^{-2}$ and $(MoO_4)^{-2}$ have d states that do not exhibit absolute bonding or antibonding character; furthermore, the Mo planar cluster reinforces the half-metallic character of the SFMO double perovskite.

P I.15 Quantum confinement effects on the low temperature specific heat of silicon nanowires: a first principles study

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In recent years Silicon Nanowires (SiNWs) have attracted considerable attention due to their possible applications in microelectronics as channel in field effect transistors and other applications. A correct understanding of thermal properties of these materials is of great importance specially in room temperatures and below to evaluate the viability of the use of these nanowires for portable applications. In this work the dependence of the vibrational properties and the low temperature specific heat with respect to the SiNWs confinement was studied using the first principles density functional perturbation theory, where the nanowires were modelled by removing atoms outside a circumference in the [001] direction of an otherwise perfect Si Crystal, and the surface dangling bonds were passivated with H atoms. Results show that at low temperatures the nanowires with higher confinement have an almost linear evolution of the specific heat, as the diameter increases the specific heat has a cubic behavior approaching to that of the crystalline Si as expected. These results could be important for the low temperature applications of these nanowires

Acknowledgments: Computations were performed supercomputer Abacus-I of CINVESTAV-EDOMEX and at the supercomputer Xiuhcóatl of CINVESTAV (Project LANCAD).

P I.16 Modelling of the effect of boron-vacancy centers on the electronic properties of diamond nanowires

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Diamond nanowires (DNws) have attracted much attention in the quantum computing field due to their capacity of emitting single photons at room temperature by introducing nitrogen-vacancy defects in their structure. However, in crystalline diamond boron doping is also well studied and boron vacancy centers have been predicted to have similar characteristics to the nitrogen vacancy centers in crystalline diamond. Therefore, in this work the effect of boron-vacancy centers on the electronic properties of diamond nanowires is studied using a first principles density functional theory scheme. The nanowires are modelled by removing atoms outside a circumference in the [001] direction of an otherwise perfect bulk Diamond crystal. The results show that the defect generates three trap-like states around the fermi energy that are spin polarized, these states could be of great importance in the emission of single photons for quantum computing applications.

Acknowledgments: Computations were performed supercomputer Abacus-I of CINVESTAV-EDOMEX and at the supercomputer Xiuhcóatl of CINVESTAV (Project LANCAD).

P I.17

Electronic properties of hydrogen passivated [001]-Si nanowire with interstitial Na atoms

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In this work, we present a density functional study of the electronic properties of hydrogen passivated silicon nanowires (SiNWs) with intercalated sodium (Na) atoms. We considered nanowires with a diameter close to 1.7nm and grown along the [001] crystallographic direction, and concentrations between 1 and 12 interstitial sodium (Na) atoms per unit cell. The initial positions of the Na atoms within the nanowire structure correspond to the so-called T_d ones, which are the most stable positions for intercalated atoms in the bulk silicon. The results reveal that the former semiconducting nanowires become metallic for all the Na concentrations, even for the case of a single Na atom per unit cell. The average binding energy of Na atoms are lower than 0.6eV, indicating that there are no Na-Si bonds in the optimized morphologies. This result contrasts with the case of SiNWs with interstitial Li atoms, where some Si-Si bonds are broken and new Si-Li bonds are created. The structure of the SiNWs is deformed when Na atoms are intercalated but it does not suffer any fracture even for concentrations of 12 Na atoms per unit cell. This result also contrasts with the case of SiNWs with interstitial Li atoms, where the nanowire structure fractures at high concentrations of Li.

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P I.18

A computational analysis of rare cell capturing within a microfluidic device with patterned herringbone grooves

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The isolation of rare cells (less than 1000/mL [1]), such as circulating tumor cells or bacteria from body fluids, is critical in many applications in healthcare and biological analysis. Among the methods for capturing rare cells (hydrodynamic, dielectrophoretic, magnetophoretic, immunochemical), the immunochemical methods [2], where the rare cells adhere to coated-with-specific-antibodies walls of the microfluidic device, are considered to have high capturing efficiency with increased selectivity. Microfluidic devices consisting of a main channel with a patterned bottom bearing herringbone grooves [3] have been proposed to enhance the interaction of cells with the walls [4]. In this work, a computational framework is developed to predict the capturing efficiency and evaluate the effect of the operating conditions, geometric characteristics, and cell size on the capturing efficiency of the device. The analysis is realized with the particle tracing method, where the cells are approximated as particles moving on the streamlines of the flow field [5]. For the calculation of the cell trajectories, the continuity and the Navier-Stokes equations are solved. A cell is considered as captured if a point of its trajectory is at a distance smaller than the cell radius to the channel walls. Compared to previous computational works [5, 6], instead of considering a uniform distribution of cells at the inlet of the device, a more realistic [7] approach is adopted, where the distribution follows the parabolic profile of the velocity. The calculations show that the capturing efficiency is increased when the a) cell size is increased, b) main channel height is decreased, and c) depth of the grooves of the herringbone pattern is increased. The effect of the Reynolds number on the efficiency is negligible for values from 0.1 to 10. These results will be utilized for the realization of a microdevice for capturing rare cells in the near future.

1. Chen, Y., et al., *Rare cell isolation and analysis in microfluidics.* Lab on a Chip, 2014. **14**(4): p. 626-645.
2. Nagrath, S., et al., *Isolation of rare circulating tumour cells in cancer patients by microchip technology.* Nature, 2007. **450**(7173): p. 1235-1239.
3. Stroock, A.D., et al., *Chaotic mixer for microchannels.* Science, 2002. **295**(5555): p. 647-51.
4. Stott, S.L., et al., *Isolation of circulating tumor cells using a microvortex-generating herringbone-chip.* Proceedings of the National Academy of Sciences of the United States of America, 2010. **107**(43): p. 18392-18397.
5. Forbes, T.P. and J.G. Kralj, *Engineering and analysis of surface interactions in a microfluidic herringbone micromixer.* Lab on a Chip, 2012. **12**(15): p. 2634-2637.
6. Wang, M., et al., *A microfluidic chip with double-sided herringbone microstructures for enhanced capture of rare tumor cells.* Journal of Materials Chemistry B, 2017. **5**(46): p. 9114-9120.
7. Cantu-Perez, A., S. Barrass, and A. Gavriilidis, *Hydrodynamics and reaction studies in a layered herringbone channel.* Chemical Engineering Journal, 2011. **167**(2-3): p. 657-665.

P I.19

Design of a Lab on a chip microfluidic device for DNA amplification

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The polymerase chain reaction (PCR) is a revolutionary method in medical diagnostics, food/environmental analysis, and forensic science. It is used for DNA amplification through thermal cycling (30-40 cycles) of the sample from ~95 (denaturation), to ~55 (annealing), and finally to ~72 $_{o}$C (extension). PCR is realized in two types of microfluidic devices, i.e., continuous flow devices, where the sample moves through fixed temperature zones, and static chamber (SC) devices, where both the device and the sample undergo thermal cycling. The design of such devices has been based either on a trial and error approach or on computational analyses aiming to temperature uniformity of the sample [1, 2]. In this work, the design is based on a detailed and systematic study: Starting from an already fabricated [with Printed Circuit Board technology] device, an optimized design is proposed with criteria the energy consumption and the total duration of the thermal cycling. Additionally, based on the PCR kinetics, the PCR protocol is optimized to maximize the DNA amplification. The focus is on a SC device where the amplification of the DNA of salmonella takes place. The study is based on a 3D modeling framework which consists of the energy conservation equation taking into account Joule heating effects in the resistive heaters realizing the thermal cycling. The efficiency of PCR is calculated by solving the mass balances of all species joining the PCR. The required PCR kinetics are extracted through a genetic algorithm [3] by adjusting the parameters of the rate coefficients to a series of measurements with quantitative-PCR [4]. Design of experiments [5] is used to define the conditions for the measurements. The optimization results into a design where the duration of the thermal cycling is ~2 times lower without affecting total energy consumption, compared to the initial design of the microfluidic device.

[1]. Ibrahim O., Jones B., Hassab M., and Op de Beeck M., Numerical Heat Transfer, Part A: Applications. **65**:11 (2014).
[2]. Chen P.-C., Fan W., Hoo T.-K., Chan L. C. Z., and Wang Z., Chemical Engineering Research and Design. **90**:5 (2012).
[3]. Li L., Wang C., Song B., Mi L., and Hu J., Industrial & Engineering Chemistry Research. **51**:40 (2012).
[4]. Rasmussen R., "Quantification on the LightCycler," in *Rapid Cycle Real-Time PCR: Methods and Applications*, S. Meuer, C. Wittwer, and K.-I. Nakagawara, Eds., ed Berlin, Heidelberg: Springer Berlin Heidelberg, 2001, pp. 21-34.
[5]. Cavazzuti M., *Optimization methods: From theory to design scientific and technological aspects in mechanics*: Springer Berlin Heidelberg, 2013.

Tuesday November 6th

9:30-10:40 Photonics, Lasers

Chair: P. Patsalas

9:30 Direct laser materials growth and processing for novel photonics

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Laser processing methods gain increasing attention owing to the development of high quality compact and low cost radiation sources available. Laser beams has been explored in a variety of pulsed laser congruent growth and direct laser micro-processing schemes. The capacity for fabrication of advanced photonics has been proven invaluable in several applications including, for example, hard-to-grow thin-film epitaxial oxides, complex glasses and other optical materials, cases in which conventional methods have failed. Physical vapor ablative growth of sensitive polymers lead to new approaches, enabling fabrication of micro-coatings and other functional structures. Processing by laser beams also benefits from the direct nature of the operation being a result of intense interaction of radiation with matter. Operations in the deep-ultraviolet range minimize thermal effects and appear to be ideal for high quality and high-resolution processing and structuring. Furthermore, femtosecond laser pulses trigger multi-phonon effects and enable deep-penetration processing in optical media. Sub-wavelength processing is also viable owing to the nonlinearity of these operations. Micro-printing approaches and selective reactive deposition gain also significant current interest in microfabrication. The paper discusses fundamentals and applications emphasizing on methods' flexibility of combined nanoimprint methods and recent developments in biocompatible photonic materials growth and high-porosity 3-dimensional materials processing.

T1

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10:00 A Ball Lens/LED micro-optical chip for imaging reflective surfaces

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With the increased need for miniaturized, portable and low-cost imaging systems new challenges inevitably emerge. One of the greatest among them is shortening the optical path and reducing the number of optical components in microscopy-based imaging systems. This work presents the fabrication of a micro-optical module that combines an excitation light source with a ball lens, intended for use in reflection-based imaging systems. The module comprises of a silicon chip that integrates a 1 mm in diameter, Sapphire ball lens and a ring-shape Light Emitting Diode (LED). The lens is mounted inside a hole that is DRIE etched in a silicon wafer while the LED is patterned on the surface of the silicon chip that surrounds the hole. A sample, when placed at close proximity to the chip (<300 μm), is being illuminated by the LED, while the reflected light is collected by the ball lens and focused to a detector. This integrated ball lens/LED scheme, reduces the excitation/emission optical path and enables reflection mode imaging to be performed without the need of bulky optics, such as condensers, collimators, beam splitters and dichroic mirrors. Key technical characteristics of the proposed module are the small diameter of the lens, the high-grade optical quality of its surface, as well as the wide emission angle of the LED, that assures uniform illumination of the sample. The fabricated module has an optical resolution of 8.8 μm over a field-of-view of approximately 250 μm. With a total optical length of less than 2.5 mm, we believe that the developed module is an ideal component for compact portable, reflection-based imaging systems

10:20 On the negative photoconductivity in AlGaN/GaN heterojunction under sub-bandgap illumination

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The photoconductivity in bulk semiconductors is directly determined by carrier recombination and the presence of deep traps. In the case of thin films, QD, QD and heterojunctions additional mechanisms are involved such as the barriers lowering, surface recombination or trapping, inter-subband and/or intraband transitions. These mechanisms may give rise to development of mainly positive or even negative photoconductivity. The negative photoconductivity, steady state or transient or persistent, has been investigated in III-As semiconductor heterojunctions as a function of the illumination photon energies. The aim of the present work is to present a detailed study of extrinsic photoconductivity in AlGaN/GaN single and double heterojunctions. The results are compared to GaN epitaxial layers, which have been used as reference material. All samples are grown with the same MOCVD (Metal-Organic-CVD) method. The study has been performed at room temperature and the photoconductivity was measured as a function of extrinsic illumination intensity and for different photon energies. Light emitting diodes with peak wavelengths ranging from 406nm (3.05eV) to 945nm (1.31eV) were used to achieve sub-bandgap excitations. In single heterojunctions both negative, for low illumination intensities, and positive, for high illumination intensities, photoconductivity was monitored. In contrast the positive photoconductivity effect was monitored in the double heterojunction structures and GaN films. In order to further investigate this effect all samples were assessed with measurements of the spectral dependence of photoconductivity, Hall and photo-Hall effect and transient response to LED illumination, all for different light intensities. The interpretation of experimental data has been based on the interaction of defects with photoexcited carriers, the barrier/s lowering and the excess carrier diffusion.

10:50-11:50 Magnetism and magnetic materials

Chair: E. Hatzikraniotis

10:50 Ultrathin antiferromagnetic lms with tunable properties

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Antiferromagnetic materials are promising for future spintronic applications owing to their advangeous properties: they are robust against perturbation due to external magnetic fields, they produce no stray fields, and present ultrafast dynamics and large magneto-transport effects. We demonstrate the growth of ultrathin micrometric islands of AFM transition metal monoxides with different compositions and lateral sizes. Combining oxygen-assisted molecular beam epitaxy on a metallic substrate with in situ Low Energy Electron Microscopy it is possible to optimize the growth parameters for each composition and thickness between a few nanometers and tens of nanometers.[1]. In particular we study mixed Co-Ni monoxides, which share the same rocksalt structure. The chemical and magnetic characterization is performed via x-ray absorption spectroscopy (XAS) and x-ray magnetic linear dichroism spectromicroscopy (XMLD). Both end members are Mott insulators with antiferromagnetic order, and Neel temperatures that range from 291 K (CoO) to 525 K (NiO). We find that while CoO grows two-dimensionally (2D) on Ru (0001) in a 3D form, precluding the formation of highly perfect micrometric islands, the addition of Ni modifies the growth mode decreasing greatly the number of nucleation points. By varying the Co:Ni composition both the size and Neel temperature of laterally micrometric ultrathin islands can be adjusted at will.

T2

[1] J. Zhu et al. J. Appl. Phys. 115, 193903 (2014)

11:10 Tuning of macroscopic magnetic features by magnetic field-induced nanoparticle self-assembly

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Magnetic nanoparticles may be organized in nanostructures assemblies with emerging properties, distinctly different both from those of isolated nanoparticles and/or of the corresponding bulk phases. The macroscopic magnetic features of such nanoscale assemblies are determined by particle interactions, giving rise, for example, to unique electrical, optical, or magnetic properties. Magnetic dipole–dipole interactions have been studied extensively as the driving force for nanoparticle long-range ordering, with the advantage that magnetic fields can be delivered remotely and instantaneously. However, relatively little attention has been devoted to how the size and concentration of magnetic nanoparticles affects their intrinsic self-assembly properties such as the magnetic superdipoles orientation and anisotropy. Here, we undertake a combined experiment–theory study aiming to a better understanding of the self-assembly of spherical iron-oxide nanoparticles. We demonstrate that, depending on the experimental parameters, such as the intensity and direction of the magnetic field, nanoparticles of different size and concentration can form one-dimensional chains, the magnetic properties of which are thoroughly characterized and studied. Furthermore, by using experimental and simulated ferromagnetic resonance spectral data, for various angles between the external magnetic field and the axis of the chain, we confirm the

nanoparticles chain formation and visualize the orientations of magnetic dipoles in the simulated structures respectively.

Acknowledgement: This research has been co-financed by the European Social Fund (ESF) and by Greece Operational Program "Exploitation of field effects on appropriate nanoparticulate carriers for modern biomedical applications" of the Research Funding Program "Human Resource Development, Education & Lifelong Learning 2014-2020".

11:30 Design of magnetic field configuration for spatially-focused heating of magnetic nanoparticles

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Magnetic nanoparticles in alternating magnetic fields may work as heating carriers and transfer some of the field's energy to their surroundings in the form of heat, a property that has attracted significant attention for use in cancer treatment as magnetic hyperthermia and/or drug delivery. To date, a crucial issue on this application is to achieve a spatial focus of heating only on selected malignant regions, while sparing surrounding healthy areas. To minimize damage of non-targeted organs, techniques to achieve spatial heating control using static field gradients are proposed. Here, we demonstrate and analyze a novel device which achieves spatial heating control through the combination of static field gradients with alternating magnetic fields. For this purpose, we use two different configurations of static magnets, the first consisting of two opposing rectangular NdFeB magnets while the second of a quadrupole with four cubic NdFeB magnets, which are placed in specific orientations in the surroundings of an AC coil region generating the alternating magnetic field. By implementing COMSOL Multiphysics we numerically estimate the magnetic field's spatial distribution presenting the so-called field free region where the static field geometry attenuates its magnitude, thus the magnetic nanoparticles rotate freely with the alternating field to give a sinusoidal magnetization response. The region surrounding this field-free region, is named as saturation region where the occurrence of a strong static magnetic field aligns the magnetic nanoparticles in its direction, thus it hinders the effect of the alternating field i.e. the magnetic heating. Eventually, only the central region undergoes a temperature shock while the surrounding area remains thermally intact.

12:10-13:30 Technologies for Energy harvesting and storage

Chair: A. Hatzopoulos

12:10 Triboelectric generators: Influence of surface modification on electrical performance

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The triboelectric phenomenon has been identified as an attractive mechanism for the conversion of mechanical energy to electrical energy. Triboelectric nanogenerators (TENGs) have been developed with an energy efficiency of up to 80% and output power up to 500 W/m2. Triboelectricity is based on the charge exchange between two surfaces that are in relative motion. It is thus expected that the triboelectric signal will depend on the surface properties (roughness) as well as the dielectric properties of the materials. In this work we investigate the use of Carbon Quantum Dot composite films and ALD deposited high-k materials as potential candidates for silicon-based triboelectric generators and we analyze the influence of surface and dielectric properties on the electrical performance of TENGs. As starting material, silicon wafers were used. An ohmic contact was formed at the backside of the wafers. Films of Carbon Quantum Dots (CQDs) were spin-coated on silicon wafers. Prior to the deposition a 100nm thermal oxide was grown on the wafers. The CQDs were synthesized by heating an aqueous mixture of Citric Acid and Urea in a conventional microwave oven. In another set of experiments, HfO_2, Al_2O_3, ZrO_2 and Ta_2O_5 films of various thicknesses ranging from 20nm to 70nm were deposited via a Savannah - 100 Atomic Layer Deposition (ALD) system (Cambridge Nanotech) at 250^{o}C. Atomic Force microscopy was used to estimate the surface roughness of all samples. The samples were evaluated in sliding mode in reference to a Kapton surface, by attaching them on an external servomotor operating at 3Hz. The output voltage was monitored as a function of time using an oscilloscope. In addition, TENGs were connected to a capacitor through a rectifying voltage quadruple circuit and the capacitor charging was monitored as a function of time. From the analysis of the results we gain valuable information for the mechanisms governing the electrical performance of TENGs.

T3

12:30 Silicon nanoparticles enwrapped with graphene as anode material for Lithium ion batteries

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Silicon is a promising material in lithium ion battery technology. As negative electrode it exhibits 4200 mAh/g theoretical capacity which is way higher than graphite commercial electrodes, with 350 mAh/g theoretical capacity. However, silicon has volume changes during lithiation and delithiation process, up to 300%, which result in cracking and pulverization leading to a short cycling life. Another problem that appears due to the volume changes is the continuous formation of solid electrolyte interface (SEI) after each cycle and the fast decomposition of the electrolyte. Various methods have been proposed to solve this issue such as creating special coating, reducing

the size of silicon to nanoparticles, or creating nanostructures with hollow or void space for the silicon to be able to expand. Graphene is a fine candidate to be used as a coating for silicon due to its mechanical strength and high conductivity. Silicon in nanoparticle form has more space to expand during lithiation process thus pulverization is avoided, whereas, graphene enwraps silicon nanoparticles protecting them and increasing the electrical conductivity of the electrode. SEI is formed mostly on graphene instead of silicon which decreases the fast decomposition of the electrolyte. In this work, silicon nanoparticles are mixed with graphene through ball milling. The resulting electrode had gravimetric capacity of 600 mAh/g, areal capacity of 1.4 mAh/cm_2, and lasted for 280 cycles, whereas bare silicon nanoparticles electrodes usually last for 40 – 60 cycles, with a gravimetric capacity of 2000 mAh/g. Even though the capacity is far from the theoretical capacity of silicon, it is better than graphite (350 mAh/g) and has better cycling life than bare silicon.

12:50

Electrochemical study and modelling of activated carbon cloth with reduced graphene oxide coating as electrode for supercapacitors

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Modern technological advances have raised the need for more efficient and portable energy storage devices. There is a great demand in devices that can deliver high power and high energy density. Batteries exhibit high energy density but lack high power density. To this end, supercapacitors can be a key factor, as they exhibit high power density, long cycle life, and minimum charge separation. Two-dimensional materials such as graphene and its derivative graphene oxide seem promising as they possess reasonably high electric conductivity and high surface area.Carbon cloth (CC) is a material with high electrical conductivity and low cost. However, its low gravimetric capacitance (~1 F/g) is an inhibiting factor for its widespread use. A fine method to enhance this parameter is called "activation" (ACC) and is carried out by oxidizing the material in solution processing and by removing the oxides carbons in a single step.
Alternatively, graphene oxide is another promising material which exhibits high surface area, although it has low electrical conductivity. Graphene oxide can be reduced to achieve better conductivity, either by chemical reduction or thermal reduction methods. High gravimetric capacitance up to 348 F/g has been reported with chemically reduced graphene oxide (rGO).
In this work, ACC/rGO electrodes are fabricated and tested in Swagelok® type cells. The cells are characterized with Cyclic Voltammetry and galvanostatic measurements. The first gravimetric capacitance is around 5 F/g and needs to be increased, the Voltage to Capacitance profile exhibits an electrochemical effect around 0.55 V and there is a capacitance fading at the first 20 cycles which also indicates electrochemical phenomena. To further investigate the effect of the activation time on the corresponding electrochemical phenomena, the equivalent electrical circuit will be studied, and the electrical parameters will be extracted.

13:10

Advances in micro& nano-structured thermoelectric materials for energy harvesting applications

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The need of alternative “green” energy sources has recently renewed the interest in thermoelectric (TE) materials, which can convert heat to electricity or, conversely, electric current to cooling. Thermoelectric devices have thus gained importance in recent years as viable solutions for applications such as spot cooling of electronic components, power generation in remote space stations and satellites, generation of electricity from waste heat, etc. These solid-state devices have long been known for their reliability rather than their efficiency; they contain no moving parts, and their performance relies primarily on material selection. Research in recent years has been focused on developing both thermoelectric structures and materials that have higher and higher efficiency. The thermoelectric performance of a material can be estimated by the so-called figure of merit, $ZT=\sigma S^2 T/\kappa$, where S is the Seebeck coefficient, σ and κ are the electrical and thermal conductivity respectively and T is the absolute temperature. Thus, in order to achieve high ZT values, thermoelectric materials must possess a special combination of electrical and thermal transport properties, namely, a high (metal-like) electrical conductivity, a high (insulator-like) Seebeck coefficient, and a low (glass-like) thermal conductivity. In conventional thermoelectric theory, the power factor (σS^2) is maximized by optimized doping while the thermal conductivity is minimized by alloying. Micro and nano-structuring can significantly enhance ZT in comparison with the usual bulk TE materials. Effective strategies for improving ZT involve decreasing the thermal conductivity by alloying and at the same time inducing inclusions that extend over a wide scale-length, from micro-scale to nano-scale, which act as scattering centers and reduce the mean free path of heat carrying phonons. Further enhancement of ZT may be obtained by enhancing the power factor via the electronic structure engineering and converging of multiple bands, and the control of the carrier mobility with matrix/inclusion band alignment. This paper reviews the recent developments and current trends in bulk TE materials in which the ideas of nano & micro-structuring and band alignment & band engineering are synergically applied, resulting in a high thermoelectric performance.

15:00-16:50 Emerging Devices and Technologies

Chair: N. Konofaos

15:00 Quantum computing with quantum walks

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15:30 Simulation of a Vacuum Transistor

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We have examined the electrical characteristics of the following structure simulating a vacuum transistor. The structure consists of two metallic pins resting at a distance d_1 on an insulating substrate and a planar metal gate above it at a distance d_2. Field emission from the left pin to the right one has been examined under the influence of both the gate voltage V_g and the (extracting) drain voltage V_d. To make the calculation of the tunnelling potential easy we have represented the two pins as stacks of spheres as shown on the diagram. The current $I_d(V_d, V_g)$ has been calculated by applying the WKB approximation along the radial lines of the emitting tip, at each angle θ,φ of the emitter, i.e. a 3-dimensional problem has been solved. From the characteristics $I_d(V_d, V_g)$ the so called transconductance $\frac{\theta I_d}{\theta V_g}$ has been obtained. Comparisons to solid state transistors are made.

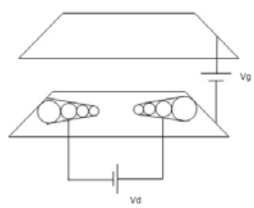

Figure 1. Electrical structure simulating a vacuum transistor

T4

15:50 JFETLAB – An Online Simulation Tool for Double Gate Junction FETs

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Nanohub.org is a site that is dedicated to promoting research collaborations in nanotechnology and providing online resources (simulation tools, Verilog-A models, lectures etc.) for educational and research purposes. The simulation tools provide unique insight into material or device physics. In this work we present an online tool called JFETLAB that has been published in Nanohub.org.

JFETLAB simulates the static and dynamic behavior of Double Gate JFETs in all regions of operation. The tool is developed in Octave and it is based on a novel, charge-based, model that was presented in [1-2]. The tool's capabilities are demonstrated and validated using TCAD simulations. The model is physics-based and relies only on the device's physical and electrical parameters (inputs). The user may define the JFET's channel width, length, thickness, the channel and gate doping concentrations, as well as temperature. The user may choose among different material settings to simulate the device (silicon, SiC, GaN). JFETLAB's main outputs are drain to source current, transconductances and transcapacitances. The drain current is calculated from drift-diffusion transport equation. The mobile charges at source and drain are calculated from a detailed analysis of potential distribution across the channel from gate to gate. The resulting model is continuous from sub- to above threshold regime and from linear to saturation operation. The transconductances are obtained analytically from the differentiation of drain current with respect to terminal voltages. The transcapacitances are obtained from the differentiation of the total node charges. This is the first model of JFETs to present a unified approach to model charges and transcapacitances ensuring charge conservation in transient simulation. The user may plot electrical characteristics in embedded graphs which may be exported as graphics or as explicit data. Sweeps on device parameters, bias and temperature are available. The user may produce graphs with appended results from different simulations. Hence, JFETLAB is a versatile tool for the detailed investigation of JFET fundamental electrical behavior. Due to its physical basis, JFETLAB is a unique tool deemed to be useful in research as well as in education.

[1] N. Makris, F. Jazaeri, J.-M. Sallese, R. K. Sharma, M. Bucher, "Charge-based modeling of long-channel symmetric double-gate junction FETs – Part I: Drain current and transconductances", IEEE Trans. Electron Devices, 65(7), 2744, Jul. 2018.
[2] N. Makris, F. Jazaeri, J.-M. Sallese, M. Bucher, "Charge-based modeling of long-channel symmetric double-gate junction FETs – Part II: Total charges and transcapacitances", IEEE Trans. Electron Devices, 65(7), 2751, Jul. 2018.

16:10 Undermask penetration for different crystal orientations in 4H-SiC TSIVJFETs

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Ion implantation is the only practical method for local doping in SiC as dopants diffusion coefficients are very small. Therefore, ion implantation is used in the fabrication process of most SiC devices. Channeling is one of the issues to be addressed when employing ion implantation. Lateral undermask channeling straggling is critical in many cases like well formation in MOSFETs and gate formation in JFETs. The straggling has been simulated by various models [1 , 2 , 3] for Al implantation of 4H-SiC, although contradictory results have been reported. In the present work, the undermask lateral straggling for different crystal orientations has been studied on 4H-SiC trench-singly-implanted vertical junction field effect transistors (TSI-VJFETs). A special mask set has been employed with different orientation (0, 30º, 60º and 90º) of the source pillars and gate trenches stripes for this reason. Obviously, difference in lateral straggling according to source/gate stripes orientation will influence the channel width value. Fig. 1 shows the variation of threshold voltage with the stripe orientation angle and the channel width values determined from SEM cross-section profiles as well calculated theoretically from the threshold voltage values. Fig. 2 shows the variation of the Ron value normalized with the estimated channel length from 1-D implantation profile simulations. In this way, the direct dependence of the Ron on the channel width value is presented and discussed.

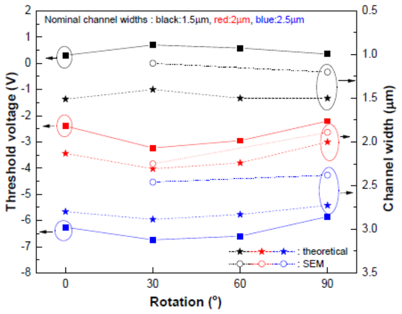

Fig. 1: Vth and extracted channel width vs structure rotation angle with different channel openings.

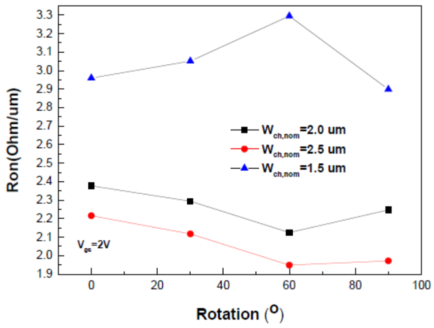

Fig. 2:Normailized Ron vs structure rotation angle with different channel openings.

16:30

Graphene monolayer treated with UV irradiation for large area FETs by optimized electron beam lithography

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Graphene is one of the most emerging materials for various technology directions. For “Beyond CMOS” and “More than Moore” devices, the mechanism of electrostatic doping, the high frequency operation and the possibility for ballistic transport of carriers make graphene very attractive for a variety of applications; from high frequency transistors to high resolution biosensors. In this paper, we present our preliminary results on the fabrication of large area bottom gate MOSFETs, suitable for sensors. In order to achieve high performance MOSFET devices we optimized the graphene transfer procedure onto 10nm SiO_2 layers, thermally grown on n+ -Si (~0.003 Ω.cm) wafers. The CVD graphene monolayer on Cu was transferred using a supporting PMMA layer. Optimization of Cu etching process and PMMA cleaning was investigated by Raman measurements. Graphene channel was defined by dry etching, while source/drain Pt contacts were sputtered and formed by metal lift-off. Raman studies in large areas of graphene films revealed that our UV assisted cleaning method after transfer improves material’s characteristics. More specifically, transfer characteristics revealed that graphene is p-doped and thus the current under negative gate bias is significantly higher than the current under positive bias. The Dirac point was shifted about +3V and also no hysteresis was observed either in Ids-Vgs or Ids-Vds characteristics. Both findings suggest relatively low density of trapped charges at the graphene/oxide interface. The extracted field effect mobility for electrons was found about 1300 cm2/Vs while for holes it was about 2000 cm2/Vs. Finally, we didn’t observe significantly degradation of the device performance after several months.

Acknowledgements: We gratefully acknowledge the Greece-Russia bilateral joint research project MEM-Q (proj.no./MIS T4ΔΡΩ-00030/5021467) supported by GSRT and funded by National and European funds.

17:20-19:00 Poster Session II

Chair: D.H. Tassis, G. Dimitrakopulos

P II.1

Study of UTBB FD-SOI MOSFET transistors' degradation with TCAD simulation tools

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This work aims at evaluating/assessing the degradation of the UTBB FD-SOI MOSFET transistors after applying electrical stress. To achieve this, a selection of proper combination of physical models and their respective parameters, is initially required. The procedure begins with the definition of a 2-D structure of each device and the estimation of their input characteristics (I_D-V_g) for different combinations of physical models. The final selection of the physical model combinations is proposed after fitting the input characteristics (theoretical versus experimental data) for various bias conditions and trial set parameters - for all the available (measured) devices. The forward current of the above devices can be described with the classical drift diffusion model, while the local band to band models can be used for successful simulation of the reverse current. The acquisition of proper physical models along with an optimum set of parameters enables us to study the degradation of a UTBB FD-SOI MOSFET transistor with 30nm channel length, by increasing the amount of interface and bulk traps in certain areas (near the drain) of the device as the stress time increases. In addition, the induction of a series resistance was necessary to fully explain the electrical behaviour of the device. Thus, the evolution of the defects with stress time in the device is revealed and the degradation in the device's performance is explained. The results suggest the existence of bulk traps with energy distribution along the transistor's body and also, the evolution of the damaged regions (extent) is revealed.

P II.2

Simple techniques for strain engineering of few layer MoS_2 membrane

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Research is now paying particular attention to 2D atomic crystals such as isolated monolayers and few-layer crystals of molybdenum disulphide (MoS_2) and other dichalcogenides. 2D crystals can retain its structural integrity at much larger strains than those achievable in bulk 3D materials, mainly due to the absence of imperfections at their surfaces. Moreover, highly anisotropic strain in 2D sheets is limited into a small area inside a single crystalline domain and far from clamping points and edges. Therefore, strain engineering, as a general strategy employed in semiconductor manufacturing to enhance device performance, can be adapted to van der Waals materials to alter their electronic properties[1]. Simple techniques for strain engineering of MoS_2 single and few layer membranes supported onto polymeric substrates are presented. In CVD grown MoS_2 the difference in thermal expansion coefficients between the substrate and MoS_2 crystal imposes significant tensile strains on the crystal[2]. Few layer MoS_2 sheets are mechanically exfoliated onto SiO_2 covered by either PMMA or a partially cured SU8 thin films. In the case of the PMMA thin film we have used various laser sources to sculpture holes and wells onto the underlying polymer. 2D crystal is deformed by conforming onto the shape of the well, while it is suspended onto the holes. The partial curing of the SU8 thin film, leads to the formation of air bubbles with diameters of ~3 μm that are trapped between the polymer and the atomic sheet. The air bubbling deforms the 2D membrane forming a hemisphere imposing a strain pattern in the membrane. AFM, Raman and photoluminescence microscopies are used to measure and analyze the mechanical strain and the subsequent changes in the optical properties of the studied MoS_2 crystals.

[1] Wang, Q. H. et al. Nat Nano 7 699-712 (2012).
[2] Michail, A. et al. 2D Mater. 5 035035 (2018)

P II.3

Synthesis and spectroscopic study of two-dimensional WS2 crystals

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Two-dimensional semiconducting transition metal dichalcogenides (2D-TMDCs) such as tungsten disulfide (WS2) have attracted significant attention in the past few years since they combine a unique set of physical phenomena including exitonic effects, spin-orbit, spin-valley coupling and many-body interactions. Moreover, these materials have shown a great potential for a diverse set of applications such as optoelectronics, nanophotonics, renewable energy and spintronics. Before any of these applications come to real life the development of large scale production methods are necessary, as was previously shown for the case of graphene. In this work, a scalable and atmospheric pressure CVD method for the production of 2D-WS2 crystals is presented. The CVD method involves the reaction of a tungstate salt and sulfur vapors in high temperature (800°C). By this route, large area triangular monolayer WS2 crystals with lateral dimensions greater than 100 μm can be fabricated. The produced crystals are studied by means of Raman and Photoluminescence spectroscopies and are compared with their exfoliated counterparts. It is shown that grain boundaries can be readily identified by the PL response of the CVD grown crystals. Moreover, the effect of growth conditions on the morphometric parameters of the 2D crystals will also be discussed.

P II.4

Weak Inversion Ring Oscillator Design Study in 65nm CMOS technology under Total Ionizing Dose Effects

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Ring Oscillators (ROs) comprise a very basic circuitry, while being widely used due to versatility. Their application varies from testing technology process variations and temperature effects on wafer to serving as voltage controlled oscillators. This plethora of applications appoints to the imperative study of these simple circuits, even strongly when they operate under harsh conditions such as radiation. It has been reported [1] that several transistor design parameters are affected caused by exposure to radiation, such as threshold voltage (V_{TH}), slope factor (n) and mobility (μ), more specifically under 100, 200 and 500 MRad(Si02) Total Ionizing Dose (TID). The impact of the degradation of these parameters in design and especially in RO design has not yet been thoroughly explored. In this work, we examine the performance of an inverter-based RO designed in 65nm CMOS technology under three TID levels (100, 200 and 500MRad (Si02)) at 25o C in terms of selected design parameters susceptible to radiation. The RO is designed in weak and strong inversion using BSIM4 model and combining different MOST geometries and number of odd stages. The immunity of the design under the TID levels is explored simulating the RO with different MOST parameter sets, which correspond to different TID conditions, and obtaining the oscillation frequency and consumption, with an attempt to pinpoint the reason of differentiation. The performance variation is quantified using as a reference the frequency and consumption of a RO simulation under prerad mosfet model parameters.

[1] Chevas, L., Nikolaou, A., Bucher, M., Makris, N., Papadopoulou, A., Zografos, A., ... & Faccio, F. (2018, June). Investigation of Scaling and Temperature Effects in Total Ionizing Dose (TID) Experiments in 65 nm CMOS. In 2018 25th International Conference" Mixed Design of Integrated Circuits and System"(MIXDES) (pp. 313-318). IEEE.

P II.5

NiTi Memristive Behavior

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The introduction of the concept of a fourth electrical element, resulted from the relation symmetry between four basic electrical magnitudes, namely voltage, current, flux and charge [1]. Since the HP-Labs have realized the first memristor nano-device in 2008 [2], a lot of research has been taking place in this scientific area. The NiTi smart alloy is a conductor with a high electrical resistance, which allows for substantial Joule heating. Due to heating a transition between two lattice phases, the martensite and the austenite phase appears. This transition happens by crossing through an intermediate R phase. The thermal activation energy between the two lattice phases is quite low. Since these phases demonstrate different electrical resistance, a mechanism for memristive behavior there exists. In [3] experimental measurements, presenting resistance scaling, in accordance to the NiTi device temperature, appear. Apparently, dc current driven through the device to raise its temperature, can change its crystal structure and reduce its electrical resistance. An initial characterization of a novel memristor implementation, exploiting the properties of NiTi smart alloy, was presented in [4]. Further contribution to the characterization the proposed NiTi memristor is apposed in this brief. To this direction the resistivity variance as a function of the ac current flowing through NiTi wires was measured. The samples were Flexinol® LT (~70oC) NiTi wires, crimped, almost equatomical, having a diameter of 0.2mm. Measurements in the ac domain, confirming the memristive nature of these NiTi wires/devices, have taken place. These measurements included the device's response to triangular current excitation, as well as to pulse driving. In all cases, a study of the noise registered has taken place. The memristive behavior is evident and follows the relative theory. Concluding, it has to be noted that such a device can be scaled down for CMOS fabrication and integrated into ICs.

Acknowledgment: The authors acknowledge support to EU ICT COST MemoCIS IC1401.
[1] L. Chua. *IEEE Trans Circuit Theory*. **18**(5), 507, 1971
[2] D. B. Strukov *et al. Nature*. **453**, 8, 2008
[3] J. Georgiou *et al*. *Electr. Lett.* **48**(14) 2012
[4] S.G. Stavrinides *et al*, in MEMRISYS 2017, Athens, Greece.

P II.6

Electrical characterization of Carbon Quantum Dots thin films

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Carbon-based fluorescent nanomaterials, including Carbon-based Quantum Dots (CQDs) have attracted significant attention due their excellent optical properties, biocompatibility, chemical inertness and low-cost synthesis easily obtainable sources of precursor compounds. Moreover, the ability to control their properties by facile surface functionalization has rendered them ideal candidates for numerous technological applications, including photocatalysis, chemical sensors and organic LEDs. However, although extensive research has been performed in determining optical properties and identifying the underlying mechanics, no significant work has been presented in determining the electrical properties of films containing CQDs as well as the charge transport mechanisms. In this work, we study the electrical properties of a nanocomposite carbon-based material, comprised of N-doped CQDs in an attempt to identify the various mechanisms that determine the electrical conductance. The nanocomposite carbon-based material was synthesized by microwave-assisted pyrolysis and carbonization of an aqueous mixture of citric acid and urea. Structural characterization revealed the graphitic core of CQDs and their quasi-spherical shape, approximately 3–7 nm in diameter, as well as functional groups, such as carboxyls, amines, etc., that appear to decorate the surface of these nanoparticles. For the electrical characterization, capacitors were fabricated on n-type (100) silicon wafers. At first, an aluminum contact was formed on the back side of the wafers. Subsequently, CQD thin films were deposited by spin coating followed by thermal annealing, to remove the solvent from the film. A top aluminum contact was deposited to form capacitor. Subsequently, the structures were electrically characterized by C-V, C-f and

G-f measurements in the temperature range from 173K to 473K in steps of 20K. Structures were also characterized, in the same temperature range, by I-V measurements, to evaluate the different conduction mechanisms. The applied DC voltage was in the range of 0V to 80V. The activation energies were calculated for each conduction mechanism.

P II.7

Comparison of impact ionization models for 4H-SiC, through breakdown voltage simulations in room temperature

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Simulation with a finite element method has become a major and important tool that can explain the physical behavior of electronic devices. The 4H polytype silicon carbide (4H-SiC) has been extensively used over the last decade, but both the physical models and their parameters are susceptible to many improvements, since there remain several ambiguities – uncertainties. Enhancements to models and parameters are necessary to produce more reliable 4H-SiC device breakdown voltage predictions with device simulation tools such as SILVACO ATLAS. We conducted a comparative study of the simulated breakdown voltage of 4H-SiC devices, based on experimental data of impact ionization coefficients in 4H-SiC, for the most widely used impact ionization models. The devices chosen for the study were two diodes for which detailed description concerning geometry (sizes), doping, and FGR (floating guard rings) are known. The breakdown voltage accuracy was examined by using the impact ionization models Selberherr (isotropic) and Hatakeyama (anisotropic). The parameters of both models were left as defined within the SILVACO ATLAS tool (defaults). In addition, the impact of the mesh density is examined as well. We found that the impact of the simulation tools mesh density is crucial and if ignored, will produce wrong results. Among different models, the accuracy with a well defined mesh density yielded best result for the Selberherr model. For this model the optimum model parameters values were chosen among measured impact ionization data and simulation sets. It was found that the best Selberherr parameters are those, that fit the Loh's measurement data. The best fit parameters yielded the most accurate V_{br} results for 4H-SiC based devices. Finally, a method has been proposed in order to use directly the experimental data of impact ionization coefficients in respect to the electric field magnitude.

P II.8

Electrical characterization of metal/ a-SiC:H/Si MIS capacitors for DNA sensor application

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DNA sensors are significantly studied since the DNA analysis could enable the diagnosis of certain diseases, evidence the existence of serious viruses inside an organism or analyze specific data in forensic science. A low-budget method for the detection of biomolecules can be based on the use of a microelectronic biomedical sensor, for example a thin film transistor (TFT). Si-nanowires (NW) biosensors show reduction of their stability with time under physiological conditions due to the degradation of silicon surface. The encapsulation of Si with a more chemically stable material such as a-SiC can solve the instability problem of the transistor as silicon carbide (SiC) shows higher inertness and resistance to solutions inside a living organism. In this work, the deposited (hydrogenated amorphous silicon carbide (a-SiC:H) by Plasma Enhanced Chemical Vapor Deposition (PECVD) is characterized through the study of metal/a-SiC:H/Si structures. Samples were fabricated having different thickness values (50, 100, 200 nm) of the PECVD deposited a-SiC:H layer. For the further investigation of the a-SiC:H/Si interface the C-V characteristics were extracted in different frequencies. In addition, low and high frequency method was applied for the extraction of the density of interface states as a function of the gate voltage that varied between 10^9 and 10^{13} $cm^{-2}V^{-1}$. Finally, the conduction mechanism of the leakage current was identified by plotting the current density against the applied vertical electric field. It

was found that the leakage current obeys the Poole-Frenkel emission mechanism, in which the transport of the carrier takes place from the trap energy to the valence band. In conclusion, it can be stated that the a-SiC:H could successfully be used as an insulator layer since its insulating properties along with the a-SiC:H/Si interface quality enable its use in a back-gate field effect transistor for DNA detection.

P II.9

Substractive Plasma Nanoassembly: A technology for the fabrication of hierarchical structures

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Etching roughness is usually considered as an unwanted issue in plasma processing. However, there are cases, where plasma induced roughness is beneficial and may result in new functional materials with controlled properties [1]. Recently, we demonstrated plasma etching as a tool for surface nanotexturing of organic materials [2], and also as a simple, non-lithographic and low-cost process, to direct the assembly of sub-50nm periodic dots on any polymeric surface, such as PMMA [3]. In all cases, roughness formation is a result of a combined fast etching of polymer and co-sputtered deposition of material from the reactor walls. In this work, we extend our study on plasma nanoroughening and present a technology for producing hierarchy at will, namely subtractive plasma nanoassembly, the ability to control roughness, and in addition to control, the transition from quasi-ordered nanoassembly to random nanotexturing. We propose the use of a new variable electrostatic shield [4], appropriate for both RIE and ICP systems, which allows full control of the flux of co-sputtered atoms from the substrate holder, the clamping ring, the electrode or their combination, ranging from complete elimination of co-sputtering to maximum possible co-sputtering, and therefore allows full control of roughness formation during plasma etching. The result is the formation of different surface morphologies ranging from random roughness to ordered polymeric nanodots. Moreover, by varying plasma parameters such as the bias power, etching time and temperature we achieve control over the size of the nanodots. We also examine the use of the fabricated nanodots as an etching mask to transfer the pattern to silicon substrates using the same plasma reactor for the fabrication of Si nanopillars, nanowires or nanotips.

[1] Gogolides E, et al. 2011 J. Phys. D: Appl. Phys. 44 174021
[2] Tsougeni K, et al. 2009 Langmuir 25(19) 11748-59
[3] Vourdas N, et al. 2010 Nanotechnology 21(8) 85302
[4] Gogolides E, at al. European Patent, EP3261111, 2017-04-26.

P II.10

Electrical Behavior of Commercial Discrete Power VDMOS Transistors and their Compact Modelling

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The prevalence of MOS transistors in high current switching applications is established over the past decades. Vertical Diffused Metal Oxide Semiconductor (VDMOS) devices in particular are considered one of the main workhorses in industrial and commercial power switching of low, up to medium voltage and current levels, in the hundreds of Volts and Amperes range, up to high frequencies, in the tens of Megahertz range. Applications vary widely from low voltage load switching and multiplexing to high power converters (AC to DC as well as DC to DC) for the industry. For most applications designers employ rather simple models that give precedence to the parameters most involved in the application of power MOSFETs as switches, namely the threshold voltage (V_{th}), on-state resistance (R_{on}) and gate capacitance (C_{gate}). In this work we performed static and dynamic operation measurements on a statistical sample of a common low power switching VDMOS transistor of the BS170 variety, with the intention of extracting parameters that can describe in greater depth most of its safe operating area. For this purpose a charge based model called "EPFL-HVMOS" (an EKV type model) is chosen [1]. It is a physics based model that utilizes a low number of core parameters which can describe higher order phenomena. Parameter extraction was performed from the mean of the measurements. Variability of basic MOSFET design parameters, including those already mentioned, within the sample group, as well as good model fitting on measured data will be demonstrated in this paper.

[1] A. Bazigos , F. Krumenacher, J. M. Sallese, M. Bucher, E. Seebacher, W. Posch, K. Molnár, M. Tang "A Physics-Based Analytical Compact Model for the Drift Region of the HV-MOSFET," in *IEEE Transactions on Electron Devices*, vol. 58, no. 6, pp. 1710-1721, June 2011.
[2] G. Ghibaudo, "New method for the extraction of MOSFET parameters," *Electronics Letters*, vol. 24, no. 9, pp. 543-545, 28 April 1988.

P II.11

Accurate and complete nanometrology of lithographic pattern roughness: Recent challenges and advances

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According to latest evolutions in semiconductor industry, the next generation of integrated circuits with critical dimensions at sub-10nm scales will be fabricated using Extreme UltraViolet Lithography (EUVL). One of the greatest challenges of EUVL to be faced before its insertion in massive production is the edge roughness of the line/space patterns (the so called Line Edge Roughness, LER) which is caused by the stochastic shot noise effects of EUV photons and resist material composition. A prerequisite for LER control is its accurate and complete measurement. The first is challenged by the presence of noise on the SEM images used in LER metrology while the second by the stochastic nature of LER which cannot be captured by a single parameters and demands more detailed metrics. In this work, we focus on recent advances regarding both challenges of accuracy and completeness inspired by mathematical and computational methods.
Regarding the challenge of completeness:

a) we elaborate on the multifractal analysis of LER, which decomposes the scaling behavior of edge undulations into a spectrum of fractal dimensions similarly to what a Power Spectrum does in the frequency domain. Emphasis is given on the physical meaning of the multifractal spectrum and its sensitivity to pattern transfer, etching and other processes.
b) We present metrics and methods for the quantification of cross-line (inter-feature) correlations, between the roughness of edges belonging to the same and nearby lines. We will these metrics to quantify the correlations in Self-Aligned Quadruple Patterning lithography.

Regarding the challenge of accuracy, we present a PSD-based method for unbiased LER metrology and validate it through the analysis of synthesized SEM images. Furthermore, the method is extended on the use of the Height-Height Correlation Functions to deliver unbiased estimation of the correlation length and the roughness exponent of LER.

P II.12

Multifractal analysis of nanostructured polymer surfaces during plasma etching

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A very strong theoretical tool for the study of the spatial aspects of micro and nanostructured surfaces, proposed and extensively investigated during the last decades, is fractal geometry (FG). FG elaborates the scaling symmetry of surface morphology to derive a theory for the characterization, modelling and understanding of the hierarchical spatial structures of surface heights. However, when the scaling behaviour changes with height or other surface features and multiple fractal dimensions are involved in the characterization of spatial morphology, a recent generalization of FG, which is called MultiFractal

Geometry (MFG), should be taken into account. In this paper we explore the benefits of MFG in understanding and characterizing the roughness evolution of polymer surfaces during plasma treatment. Actually, our aim is twofold. First, we propose an alternative method for the calculation of multifractal (mf) spectra based solely on the positive exponents q to resolve the issues of nonlinearities commonly present in the analysis of negative q coming from the surface valleys (low-height areas). The key idea is to estimate the scaling behavior of the valleys of the initial surface through the positive exponents q of the reverse surface where the valleys are transformed to peaks. The second aim is to apply the proposed method to the multifractal analysis of the roughness evolution of plasma etched polymer surfaces vs. time. Conventional roughness analysis reveals a crossover from low to high skewness and kyrtosis at etching times from 5min to 8min indicating a morphological change where some peaks are selected to grow rapidly in height and width. The proposed mf analysis reveals a maximum of multifractality which characterizes the increased scaling heterogeneity of surface morphology at the crossover time.

P II.13

Optimization of ZnO nanowires for piezoelectric harvesters on flexible substrates

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ZnO nanostructures and nanotextured films have become the leading candidate for vibrational energy scavenging using one-dimensional piezoelectric elements towards energy autonomy of sensors, microsystems and small portable electronic devices. This is due to its unique properties as well as its low cost, wafer-scale fabrication process and the applicability of that process to a variety of substrates using low-temperature, environmentally-friendly solution-based growth. In this work, we evaluate different approaches for controlling both the geometrical as well as the electrical characteristics of ZnO nanostructures aiming to develop ZnO-based piezoelectric microgenerators for efficient harvesting of the abundant mechanical energy of the environment.
Well-controlled crystalline ZnO nanorods were synthesized on ZnO seeded substrates, both on silicon as well as on Kapton substrates, by a simple, low cost and environmentally friendly hydrothermal process. For the seeding layer, a sol-gel technique was applied. The seeded substrates were immersed in an aqueous equimolar growth solution of zinc nitrate hexahydrate ($ZnNO_3 \cdot 6H_2O$) and hexamethylenetetramine ($C_6H_{12}N_4$, HMTA) for different temperatures and growth duration. Doping of the ZnO nanorods was performed with the addition of LiNO3 to the growth solution followed by annealing at various temperatures. The thermal decomposition of the growth solution provides a reproducible means for highly oriented ZnO nanorods. The shape, orientation and distribution of ZnO nanorods was evaluated by Scanning Electron Microscopy (SEM) in conjunction with X-ray Diffraction (XRD) measurements which revealed well-oriented wurtzite (hexagonal) structure.
The electrical performance of ZnO nanostructured films was investigated as a function of the growth parameters. Capacitors were fabricated on silicon wafers with pre-existing ZnO nanostructures. A PMMA film was spin-coated on top of the nanostructures and metal contacts were formed on the front and back side. The electrical characterization of the fabricated capacitors was performed by I-V and C-V measurements. In addition, microgenerators were fabricated on flexible substrates utilizing similar growth and fabrication parameters. Analysis of the results indicated methods of improving the characteristics of ZnO nanostructures leading in optimized microgenerator performance.

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P II.14

VO_2 thin films prepared by reduction of PVD-deposited V_2O_5 on transparentsubstrates: Electrical, optical properties around SMT and relevant applications

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Vanadium dioxide (VO_2) exhibits a Semiconductor-to-Metal Transition (SMT) at T=340 K, which is deeply correlated to a reversible polymorphic change of the lattice symmetry (from monoclinic, $P2_1/C$, to tetragonal, $P4_2/mmm$) taking place at picosecond time scale. During the SMT a dramatic change of the electrical resistance and a strong modification of the optical transmittance in the near infrared region take place stimulated by thermal, optical, stress or electric field excitation. Lots of technologically promising applications utilizing the SMT of thin films of VO_2 such as fast electronic devices, light modulators, sensors, tunable metamaterials, non-volatile memory, neuromorphic computing, optical filters for high performance optical wireless communication systems, as well as "smart window" for the management of solar radiation for energy efficient buildings have been put forward in recent research. In this work, high quality VO_2 films have been obtained by thermal evaporation (PVD)-deposited V_2O_5 films on transparent (glass, quartz, and single crystalline Al_2O_3) substrates. The V_2O_5 films (estimated thickness: few hundred nm) were transformed to monoclinic VO_2 (M1) by annealing under steady gas flow. Single phase VO_2 (M1) films were identified by XRD phase analysis after annealing under pure N_2 flow with a pressure of $4 \cdot 10^{-1}$ mbar, at annealing temperature of ≈500 °C for 3 hours. According to the results of the electrical characterization, the low-current dc-electrical resistance of the VO_2 thin films exhibits a sharp SMT at T=335-340 K resulting in a drop of about 2-4 orders of magnitude, with the highest drop observed for VO_2 films deposited on quartz substrates. Same films exhibited an abrupt decrease of the optical transmittance in the near infrared (λ=1550 nm), ranging between 40-50%. An attempt is made to explain the differences of both SMT temperature and transmittance monitored for the films grown on various substrates which cannot presently be attributed to substrate properties.

P II.15

Humidity protected Platinum nanoparticles strain sensor using alumina coating

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In this work we report the effect of relative humidity (RH) on metal nanoparticles based strain sensors made on flexible polyimide substrate. Moreover, we investigate the protective properties of an alumina (Al2O3) thin film, grown by Atomic Layer Deposition (ALD). Interdigitated electrodes have been deposited using electron gun evaporation and optical lithography. Platinum nanoparticles (of a mean diameter of 4 nm) have being deposited on top of them, using a DC sputtering and gas aggregation synthesis [1]. Nanoparticle sensors are sensitive to environmental conditions (like RH) thus requiring a protective film [2]. The mean value of gauge factor (G) of these devices -prior to Al2O3 deposition- is 50 (for strain values up to 0.5%). Following Al2O3 deposition, the mean value of G drops around 19% due probably to built-in stress of the as deposited film. The thickness of the film has been determined for deposition conditions at 150 ºC for 50 and 100 cycles at 6 and 12.1 nm respectively. The differential resistance change (ΔR/R) of the NP layer with RH change has been used as a humidity protection measure. The RH' s effect is reduced significantly for both thicknesses of Al2O3 used, showing a ΔR/R change of about 1% over an order of magnitude less, compared with unprotected with alumina NP films. Additionally, fatigue tests (strain up to 0.5% for 100, 200 and 1000 cycles) have been applied as to investigate the protective properties of the Al2O3 under working conditions. Afterwards, the ΔR/R has been measured for various RH values. The results show that the protective properties of Al2O3 remain the same. The authors acknowledge support from the International Consortium of Nanotechnologies (ICON) funded by Lloyd's Register Foundation, a charitable foundation which helps to protect life and property by supporting engineering-related education, public engagement and the application of research.

1) J. L. Tanner, D. Mousadakos, E. Skotadis, K. Giannakopoulos, D. Tsoukalas, Nanotechnology, 23 (2012), 285501, 1-6.
2) P. F. Carcia, R. S. Mclean, M. H. Reily, Appl. Phys. Lett., 97 (2010), 221901, 1-3.

P II.16

Synthesis of copper ferrite and β-cyclodextrin graphene-based nanohybrids via

hydrothermal and solvothermal methods

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Graphene oxide (GO) is an interesting graphene-based material with a wide range of functional groups, such as carboxyl (COOH), hydroxyl (OH) and epoxy (C-O-C) groups. Because of its large surface area and good mechanical properties, GO and its derivatives have attracted tremendous attention for potential applications in areas such as sensors, photocatalysis, photovoltaic cells, supercapacitors as well as water treatment. Functional groups present on its surface and aromatic sp2 domains allow GO to be modified with various inorganic and organic compounds, thus resulting in novel GO based materials with combined properties. Aim of this work is to synthesize and characterize CuFe2O4/GO, β-CD/GO and CuFe2O4/GO@β-CD nanohybrid materials via solvothermal and hydrothermal methods. In particular, magnetic CuFe2O4/GO nanohybrid was successfully fabricated through solvothermal method, using FeCl3·6H2O and CuCl2·2H2O as starting materials. The process took place in a Teflon-lined autoclave at 200°C for 12 h using ethylene glycol (EG) as solvent. The as-synthesized CuFe2O4/GO nanohybrid was further decorated with β-CD via hydrothermal method. The procedure took place in a Teflon-lined autoclave at 90°C for 12 h using distilled water as solvent. In addition, β-CD/GO nanohybrids were also synthesized via hydrothermal method at 90°C and 120°C for 12 h, respectively. The obtained GO nanohybrid materials were characterized using Xray powder Diffraction (XRD), micro Raman spectroscopy, Fourier transformed infrared spectroscopy (FT-IR) and scanning electron microscopy (SEM).

P II.17

Influence of embedded nanoparticles on switching properties of bilayer metal oxide structures

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Resistive switching devices based on forming-free TiO2-y/TiO2-x bilayer structures have shown exemplary results as far as switching ratios, uniformity, endurance and retention are concerned1. By embedding Pt nanocrystals (NCs) we can narrow down the possible locations where the switching effect will evolve and thus significantly improve the inherent variability of the devices2. Besides, by employing bilayer structures we can tune the resistance levels, by creating films with low oxygen content (TiO2-x), which act practically as series resistance and, thus, force the switching effect to evolve in the layer with the higher oxygen content (TiO2-y), therefore improving the total power consumption (nW). The presence of NCs also enhances dramatically the switching ratio (>105), endurance (106 cycles) and retention (105 sec) properties. The position of Pt NCs within the switching layer was also systematically examined, by introducing NCs at different positions within the memory cell (under the Top Electrode (TE), in the middle of the device, above the Bottom Electrode (BE)). The results divulged the incorporation of the NCs under the TE yielded better memory performance, in terms of memory window (>105) and power consumption (ILRS = 1 μA and IHRS = 10 pA), which is mainly attributed to the higher enhancement of the local electric field at this position leading to the controllable creation of conducting filaments. We acknowledge support of this work by the project “Optimization of vacuum thin film and nanoparticle technologies” (MIS5002772) which is implemented under the Action “Reinforcement of the Research and Innovation Infrastructure”, funded by the Operational Programme "Competitiveness, Entrepreneurship and Innovation" (NSRF 2014-2020) and co-financed by Greece and the European Union (European Regional Development Fund).

1. Bousoulas, P. *et al. J. Appl. Phys.* **120,** (2016).
2. Bousoulas, P., Sakellaropoulos, D., Giannopoulos, J. & Tsoukalas, D. *European Solid-State Device Research Conference* **2015–** 274–277 (2015).

P II.18

TCAD simulation and AC-analysis of the UTBB FD-SOI transistor for the estimation of

the trans-capacitances.

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The purpose of this work is to implement a complete UTBB FD-SOI MOSFET process flow in a commercially available 2D TCAD-environment and estimate the trans-capacitances after an AC-analysis simulation. TCAD simulation tools were used for the definition of the theoretical structure and the comparison between the extracted and the realistic experimental data in order to achieve the best possible convergence. After the verification of the simulated and experimental I_d-V_g characteristics, figure of merits are presented for various channel lengths and back-gate bias conditions. Specifically, parameters such as the transconductance (gm), subthreshold-slope (SS) and Ion/Ioff ratio are discussed, along with their variations estimated for different bias conditions. Moreover, variations of the cut-off frequency, delay time and capacitances are also presented for estimating the perspectives of the devices for analog and RF applications.

Wednesday November 7th

9:00-10:30 Memories, MEMS, Sensors

Chair: N. Farmakis

W1

9:00 Ultrafast Laser generated Rayleigh surface acoustic waves: physics and applications on material diagnosis.

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Rayleigh Surface Acoustic Waves (SAWs) are elastic waves that are generated and travel near the surface of a materials. Generating and probing the evolution of SAWs in targets of interest has proven a valuable non-contact and non-destructive material characterization approach for detecting surface characteristics and indirectly probing inner features in composite materials. In this work we demonstrate full-field measuring techniques, based on whole-field dynamic optical interferometry, for the analysis and characterization of laser-induced Surface Acoustic Wave propagation. The optical-interferometry geometries employed here combine the use of a nanosecond (ns)- or a femtosecond (fs) laser radiation pump line for the generation of the elastic waves on metal thin films with ns laser radiation for probing the evolution of the SAWs. This pump-probe geometry allows for an out of surface metrology with a high spatial resolution of the order of a few nanometers, and an accurate spatio-temporal representation of the SAWs. In this context, we have been able to compare the generation and propagation of SAWs in metal thin films on a dielectric substrate, by laser pulses of different characteristics like laser pulse duration and energy, and probing the generated elastic wave properties, such as amplitude, velocity and penetration depth. Moreover local defects extending down to several micrometers in depth are shown to be detected with the help of the reflected and transmitted SAWs, with sensitivity which is dependent on the laser pulse duration and the characteristics of the SAWs packet, the depth of the SAWs penetration and the presence and type of the substrate material. A dynamic response of the metallic film-substrate solid structures, irradiated by a pulsed ns and fs laser pulses is also numerically investigated. A satisfactory agreement between experimental and numerical results is achieved regarding the surface wave propagation characteristics.

We acknowledge support of this work by the project "ELI - LASERLAB Europe Synergy, HiPER & IPERION-CH.gr" (MIS 5002735) which is implemented under the Action "Reinforcement of the Research and Innovation Infrastructure", funded by the Operational Programme "Competitiveness, Entrepreneurship and Innovation" (NSRF 2014-2020) and co-financed by Greece and the European Union (European Regional Development Fund).

9:30 Stiffness correction method for improving vibrations immunity of a MEMS tuning fork gyroscope

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Automotive specifications require sensors to be resilient to mechanical vibrations up to 40 kHz with an amplitude of 10g. This experimental study investigates the effect of external mechanical vibrations in a dual-mass MEMS gyroscope and focuses on vibration frequencies near the resonance frequency of the anti-phase drive mode (fDa), i.e. its operational mode. Due to its symmetrical design, it is theoretically insensitive to vibrations but actually, because of fabrication imperfections, a residual sensitivity to vibrations can be observed. This paper proposes experimentally a stiffness correction method that enables to decrease this sensitivity by compensating the stiffness and the mass imbalance of the dual-mass structure. The application of a DC voltage (Vtrimming) at the drive actuation electrode can finely balance the anti-phase drive mode by tuning the suspension stiffness through the negative electrostatic spring effect. The objectives are to keep the drive axis operational in the linear regime and to avoid spurious signal for the detection of rotation (sense axis). The experiment has been performed with a packaged gyroscope under vacuum at 0.3 mbar and with a qtsauality factor of around 7 200. The resonance frequency of the drive operational mode is 20 900 Hz and the sensitivity to vibrations is around 0.8 nA/g before correction. A trimming voltage of 34V enables to decrease this sensitivity by a factor 80 down to 10 pA/g. This reduced sensitivity allows vibrations resilience up to 20g: device operation remains in the linear regime of the gyroscope's drive mode, thus maintaining the rotation sensor functional. Future work will include the design of specific electrode to balance the structure of the gyroscope, thus reducing the required trimming voltage.

9:50 RRAM cells with Silicon Nitride as resistance switching layer

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RRAMs are considered as the most promising devices for NVM and storage class memory applications at technology nodes below 20nm. In addition, due to their memristive properties pave the way for the realization of neuromorphic prototype circuits. The majority of these devices are two-terminal MIM structures and use as insulator (active material) metal oxides in combination with proper metals. The present models assuming the oxide and metal physical and chemical properties seem that can explain the observed resistive phenomena. Nevertheless, the effect of humidity seems to play a crucial role in the reliability of RRAMs. In this context, nitride based insulators are of special importance because of their immunity in humidity and oxygen related parasitic effects. The present contribution reports on the preliminary results related to our research on MIM devices where LPCVD Si_3N_4 is used as insulating material, sputtered Cu as active (top) electrode and heavily doped Si (<0.003 Ω.cm) bottom electrode (BE). Both conductivity types of Si n and p have been tested. The devices have been characterized in terms of static I-V, resistance variability, impedance spectroscopy (IS) and retention measurements. Room temperature I-V measurements suggest that a space charge limited conduction (SCLC) is dominating through the nitride layer. According to our results the MIM diodes with p^+ Si as BE present higher variability in V_{SET} and V_{RESET} compare to those diodes with n^+ Si BE. Temperature variable measurements are currently contacted in order to identify the electronic or ionic nature of the diffusion mechanism. The fabricated devices exhibit attractive multi-state operation under different current compliance values. In addition, retention measurements at room temperature indicated that the LRS is retained for 10 yrs.

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10:10

Acetone sas micro-sensors based on graphene nanoplatelets on flexible substrates

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In this paper, we demonstrated a room-temperature acetone gas sensor based on hydrazine reduced graphene oxide. The graphene microsensors were created by drop casting graphene nanoplatelet solution on various substrates, flexible and/or transparent, including PLA, PET and glass. The graphene solution was prepared by dispersing graphene in 30% ethanol via ultrasonication. The graphene content was 1mg/ml. After the drop casting the sensors dried for 5 hours in dry air environment. The sensing properties graphene sensors were investigated by exposing it to various concentrations of acetone gas in nitrogen at room temperature. It was found that the presented sensors had a response of around 0.5% at 200ppm acetone and response time of 30 minutes. These sensors showed good repeatability and stable response in acetone concentrations as low as 50ppm. After the acetone was removed from the testing chamber the sensors returned to baseline in about 30 minutes under nitrogen atmosphere without any treatment. The flexible sensors presented good response even when bent showing potential of integration in many applications like wearables.

10:50-12:40 Novel materials and applications

Chair: M. Gioti

10:50 Nonlinear electromagnetic metamaterials: mathematical analysis, physical phenomena, and engineering explorations

N.L. Tsitsas*

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Electromagnetic metamaterials with negative effective dielectric permittivity ε and magnetic permeability μ (*double negative metamaterials*) have become a subject of intense research activity for the past twenty years. Such metamaterials exhibit significant extraordinary effects, like e.g. the reversal of Snell's law causing negative refraction, the support of backward-propagating waves as well as the possibility of obtaining a perfect lens. So far, double negative metamaterials have been mainly studied in the linear regime, where ε and μ do not depend on the fields' intensities. Nevertheless, nonlinear metamaterials, created by embedding an array of wires and split-ring resonators (SRRs) into a nonlinear dielectric, prove useful in "switching" the material properties from left- to right-handed and back, tunable structures with intensity-controlled transmission, and negative refraction photonic crystals.

In this talk, first we will present some of the mathematical methodologies applied for the analysis of the wave propagation phenomena in nonlinear metamaterials. More precisely, we will show that wave propagation is governed by a higher-order nonlinear Schrödinger (NLS) equation, describing ultra-short solitons in nonlinear double negative metamaterials. The derived NLS equations generalize the ones describing short pulse propagation in nonlinear optical fibers. Analyzing these equations, we find necessary conditions for the formation of bright or dark solitons and derive analytically ultra-short solitons solutions.

Then, we will discuss important physical properties and associated phenomena occurring in the different frequency regions of dispersive nonlinear metamaterials. Emphasis will be given on the nonlinear localization of waves in the frequency band gaps of such metamaterials. Finally, recent related engineering realizations will be overviewed.

W2

11:20 Nanoperforation of graphene with pore diameters smaller than the diffraction limit of light

J. Parthenios[1,*], S. Katsiaounis[1,2], N. Chourdakis[1], J. Polizos[1] and K. Papagelis[1,3]

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Single layer graphene is impermeable to all atoms and molecules due to its two dimensional array of tightly packed carbon atoms. To generate permeability, molecular selectivity and ultrahigh molecular fluxes, pores of specific sizes in the nm scale, and with sufficient areal density should be drilled onto the graphene lattice [1,2]. However, eliminating carbon atoms from graphene lattice in a highly controlled manner is extremely challenging. A plethora of different processes for nanopore fabrication have been proposed including chemical growth, chemical reaction etching, template-assisted fabrication, bombardment with ion or electron beams and oxygen plasma etching [2]. However, the scaling up of these methods towards nanopore membranes for use in industrial and commercial processes remains a significant challenge. In this work a technique for nanoperforation of CVD grown graphene based on fs laser treatment, is proposed. Graphene is treated in air by focusing high repetition rate fs laser pulses forming circular patterns of 1-2 μm in diameter. The pattern formation is due to the synergy of thermal and ablation effects, occurring in different time scales and affect different regions of graphene within the spot of the Gaussian beam [3]. The ablation effects destroy the graphene network forming pores with diameters ranging from a few nm up to 70 nm, an order of magnitude lower than the diffraction limit. Pore diameters and their areal density are strongly dependent on the laser treatment parameters (laser wavelength, power, focusing, and irradiation time). Yet, thermal effects become important due the high repetition rate of the fs laser resulting in graphene inflation of a region around the ablation area periphery. The proposed method can be easily scaled up for creating porous graphene membranes in various area scales from μm2 up to m2 provided that the quality of the transferred CVD graphene is exceptional.

[1]. Celebi, K. et al. Science 344, (2014) 289
[2]. Sun, P. et al. Adv. Mater. 28, (2016) 2287
[3]. Korte, F., et al., Appl. Phys. A: Mater. Sci. & Proc, 77 (2), (2003) 229.

11:40 Controlled, scalable synthesis and growth-induced strain effects in single-layer MoS2 and WS2 crystals

A. Michail[1,2,*], T. Mylonas[1], M. Douka[1], D. Anestopoulos[2], J. Parthenios[2] and K. Papagelis[2,3]

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[2] *Institute of Chemical Engineering Sciences, Foundation for Research and Technology- Hellas (FORTH/ICE-HT), Patras 26504, Greece*
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The two-dimensional (2D) counterparts of molybdenum and tungsten disulfides (MoS2, WS2) are the two most well studied members of the 2D transition metal dichalcogenides. Being direct-gap semiconductors with sizeable bandgaps in the range around 1.8 – 2.0 eV, MoS2 and WS2 pose as viable alternatives to the semi-metallic graphene, especially in applications were an electronic bandgap is required. Additionally, these materials possess a rare combination of physical phenomena such as rich exitonic effects, many body interactions as well as spin-orbit and spin-valley coupling, extending their potential use in spintronics and valleytronics. In order to integrate single-layer MoS2 and WS2 in real life applications efficient and viable production methods are required. In this work, a simple, controlled and scalable chemical vapor deposition (CVD) method for the production of 2D-MoS2 and WS2 crystals is presented. The proposed method involves the reaction of Na2MO4 (M = Mo, W) and sulfur vapors in high temperature and atmospheric pressure. This synthetic method enables the growth of either continuous MoS2 films with single and few-layered domains or homogeneous nucleated triangular MoS2 monolayers. Moreover, under similar conditions, large area single-layer WS2 crystals can be fabricated. Raman and Photoluminescence spectroscopies are employed to study the fabricated crystals. It is revealed that the growth conditions can impart relatively large mechanical strain (as high as 0.6%) on the grown monolayers, significantly affecting their electronic properties.

12:00 Computational Analysis of a–Type Edge Dislocations Along <10-10> in GaN

S. Giaremis[1*], Ph. Komninou[1], I. Belabbas[2], J. Chen[3] and J. Kioseoglou[1]

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Basal plane perfect dislocations constitute the most dominant type of dislocations involved in stress relaxation in semipolar III-nitride heteroepitaxy, as plastic relaxation mechanisms of coherently grown semipolar heterostructures of III-nitrides have been recently demonstrated to lead to the formation of misfit a-type dislocations1. The present study involves an in-depth investigation of the structural and electronic properties of these dislocations along the [10-10] direction via Density Functional Theory and Molecular Dynamics simulations. Six unique core configurations, three for each polarity type, emerged by imposing a displacement field for edge type dislocations2. The

results of structural analysis show great agreement with the theory of linear elasticity3. DFT calculations of the electronic configuration demonstrate the impact of these dislocations on the overall electronic properties of GaN. Electronic states inside the band gap are widely observed, with N and Ga atoms on the dislocation cores contributing with 2p and s type orbitals to states close to the VBM and CBM, respectively, while nonsemiconducting behaviour was observed on N-polarized core structures. These results aim to provide important details regarding one of the most commonly observed type of dislocations in semipolar grown GaN and other wurtzite type materials4.

This work is supported by the project “INNOVATION-EL” (MIS 5002772) which is implemented under the Action “Reinforcement of the Research and Innovation Infrastructure”, funded by the Operational Programme "Competitiveness, Entrepreneurship and Innovation" (NSRF 2014-2020) and co-financed by Greece and the
European Union (European Regional Development Fund).

1 A.E. Romanov et al, J. Appl. Phys. **109**, 103522 (2011)
2 R. deWit, J. Res. Natl. Bur. Stand. Sect. A Phys. Chem. **77A**, 607 (1973)
3 J.P. Hirth and J. Lothe, Theory of Dislocations, 2nd ed (Krieger Pub. Co, 1982)
4 S. Giaremis et al, J. Appl. Phys. **123**, 244301 (2018)

12:20 Quantitative Characterization of Ultrathin $In_xGa_{1-x}N$/GaN Quantum Wells by HRSTEM

I.G. Vasileiadis[1], C. Bazioti[1], J. Smalc-Koziorowska[2], S. Kret[3], E. Dimakis[4], N. Florini[1], P. Chatzopoulou[1], Th. Kehagias[1], T. Suski[2], Th. Karakostas[1], T.D. Moustakas[4], Ph. Komninou[1] and G. P. Dimitrakopulos[1,*]

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[2] Institute of High Pressure Physics, Polish Academy of Sciences, Sokołowska 29/37, 01-142 Warsaw, Poland
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[*] *Corresponding author: gdim@auth.gr*

Short period superlattices (SPSs) of ultrathin $In_xGa_{1-x}N$/GaN quantum wells (QW) are promising for the development of advanced optoelectronics devices operating in the green part of the spectrum and topological insulator applications. The thickness of such QW ranges from only one to a few (0002) monolayers (ML). High resolution scanning transmission electron microscopy (HRSTEM) observations were employed in order to obtain the average composition and strain of such ultrathin layers along the <11-20> cross sectional projection [1]. Compositional and strain quantification was performed using Z-contrast analysis and peak finding. Energetically relaxed atomic supercells obtained by empirical potential calculations were employed as input for multislice HRSTEM image simulations under the frozen lattice approximation. Thickness dependent graphs of $In_xGa_{1-x}N$/GaN intensity ratios were constructed from the simulated images and employed for Z-contrast quantification. The correlation between composition and the strain state of the QWs was determined by comparing the indium content to the strain measurements. The influences of possible QW discontinuities and grading, as well as of the thin foil relaxation effect on the determined strain and indium content of the QWs were studied by finite element analysis.

[1] G. P. Dimitrakopulos, et al., *J. Appl. Phys.* **123**, 024304 (2018).
Acknowledgments: Partial support under the Sonata 8 (2014/15/D/ST3/03808) project of the Polish National Science Centre and the IKY-DAAD project “ULTIMAT” is gratefully acknowledged.

12:50-14:00 Closing Ceremony

12:50 **Plenary talk**

Recent Progress in Nanoelectronics

C.A. Dimitriadis

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13:30 **Closing remarks and award ceremony**

UNDER THE AUSPICES OF

MICRO & NANO SCIENTIFIC SOCIETY

ARISTOTLE UNIVERSITY OF THESSALONIKI

SCHOOL OF PHYSICS

SCHOOLS OF INFORMATICS

SCHOOLS OF ELECTRICAL & COMPUTER ENGINEERING

RESEARCH COMMITTEE (AUTH)

7th International Micro & Nano 2018 Conference

5-7 November 2018

Aristotle University Research Dissemination Center (KEDEA)

Materials for Electronics, Photonics and Sensors:

- ✓Semiconductors
- ✓Porous materials
- ✓Dielectrics
- ✓Organic materials
- ✓Self-assembling-self-organizing materials
- ✓Magnetic Materials
- ✓Metamaterials
- ✓Photonic Structures.

Electronic, Optoelectronic and Photonic Devices:

- ✓CMOS devices
- ✓Emerging non-CMOS Devices.
- ✓Microwave Devices
- ✓Thin Film Devices
- ✓Light Emitting devices
- ✓Organic electronic devices
- ✓New Optoelectronic and Photonic Devices.

Micro and Nano – Fabrication:

- ✓Front-end back-end processes for IC fabrication
- ✓Patterning Technologies
- ✓Epitaxial growth
- ✓Self-assembly
- ✓Integration
- ✓Micromachining
- ✓Process Modeling and simulation.

Sensors and Actuators:

- ✓Physical sensors
- ✓Chemical sensors
- ✓Bio-chemical sensors
- ✓Energy Harvesting devices
- ✓Microfluidics
- ✓MEMS
- ✓Detectors.

Energy and Micro Nano-technology

- ✓Energy storage
- ✓Microbatteries,
- ✓Micro- and nano materials for electrodes,
- ✓Supecapacitors
- ✓Energy harvesting (solar cells, electrostatic, piezoelectric).

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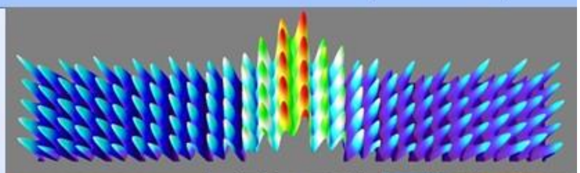
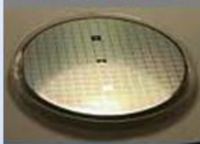
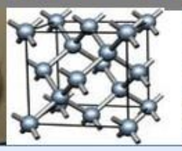
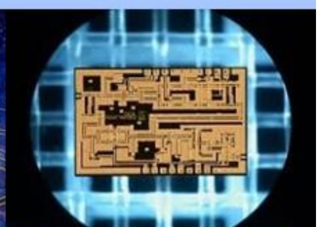





INVITED SPEAKERS

Francois Andrieu - CEA LETI
Charalabos Dimitriadis - Aristotle University of Thessaloniki
Elias Ayfantis - Aristotle University of Thessaloniki
Ioannis Karafylidis - Demokritus University of Thrace
George Litsardakis - Aristotle University of Thessaloniki
Nektarios Papadogiannis - Technological Education Institute of Crete
George Papaioannou - National & Kapodistrian University of Athens
Nikos Tsitsas - Aristotle University of Thessaloniki
Nikos Vainos - University of Patras


ΕΠΙΤΡΟΠΗ ΕΡΕΥΝΩΝ

Micro & Nano Scientific Society

CONFERENCE PROGRAM

Monday November 5th

Micro&Nano 2018: OPENING

9:00 **Welcome**

Conference Chairpersons: D. Tassis, N. Konofaos

9:15 **Welcome by the Micro&Nano Society - Greece**

President: E. Gogolides

9:30 **Plenary Talk**

3D-monolithic integration for CMOS and post-CMOS applications, Francois Andrieu

10:20-11:50 Micro & Nano-electronic devices

Chair: C.Tsamis

M1

10:20	**On the Physics of Dielectric Charging in Microelectromechanical System Electrostatic Devices**	**G.Papaioannou (Invited)**
10:50	Electrical characterization of alumina in MIM and MIS capacitor structures	E.Hourdakis
11:10	Enhancement of responsivity of a ZnO/Si heterojunction formed on laser-microstructured Si substrates	S.Gardelis
11:30	The reductive action of Al on Al_2O_3 layers and its influence on the interface trap properties of $Al/Al_2O_3/Ge$ MIS structures	V.Ioannou-Sougleridis

11:50-12:00 Coffee break

12:00 **Announcements by the Micro&Nano Society - Greece**

E. Gogolides, G. Konstantinides, S. gardelis, M. Bucher, F. Farmakis, D. Tassis, N. Konofaos

12:15 **Announcements by the INNOVATION.EL: A National Infrastructure in Nanotechnology, Advanced Materials and Micro/Nanoelectronics**

C. Tsamis, Institute of Nanoscience and Nanotechnology, NCSR "Demokritos"

12:30-13:30 Concepts, modeling and techniques

M2

Chair: S. Stavrinides

12:30	Advanced aerogel processing: A novel nanotechnology concept	K.Papachristopoulou
12:50	Deep learning nanometrology	V. Constantoudis
13:10	High optical quality cellulose films grown by deep ultraviolet laser ablation of natural raw cotton and processed alike	V. Karoutsos

13:40-14:45 Lunch break

14:50-16:20 Nano-Bio-systems

M3

Chair: A. Hatzopoulos

14:50	**Development of a portable diagnostic device for the detection of protein biomarkers**	**G. Litsardakis (Invited)**
15:20	Low-cost, PCB manufacturable microdevices for fast DNA amplification	G. Kaprou
15:40	Use of a novel graphite/SiO_2 hybrid electrode modified with hybrid organic-inorganic perovskites for the determination of losartan	P. Nikolaou
16:00	Integrated, fast, cost effective, semi-automated Lab on a Chip for foodborne pathogen detection	E. Gogolides

16:20-16:40 Coffee break

16:40-18:10 Critical nanoscale phenomena

M4

Chair: P. Dimitrakis

16:40	**On the role of Fractional Calculus and Fractal Analysis in Modeling Material Problems at Micro/Nano Scales**	**K.Parisis (Invited)**

17:10	Intermittency-induced criticality in the random telegraph noise of nanoscale UTBB FD-SOI MOSFETs	S.G. Stavrinides
17:30	Hot Carrier Degradation of nanoscale Triple Gate Junctionless nanowires	T.A. Oproglidis
17:50	Charging properties of SiNx with embedded CNTs for MEMS capacitive switches application	G.Papaioannou

18:20-19:50

Poster Session I

Chair: D. Tassis, M. Bucher

P I.1	Atomistic approach of interfacial segregation in FCC metallic alloys	Balahouane Lezzar
P I.2	Detection of BRCA1 on partially reduced graphene oxide biosensors	S. Chatzandroulis
P I.3	On the Effects of Environmental Factors on the Functionality of Modern Dynamic Random Access Memory Modules	N. A. Anagnostopoulos
P I.4	"Quantum interference in pump-probe absorption of coupled quantum – plasmonic nanostructures: Comparison between metallic nanoparticles and carbon nanostructures"	S. Evangelou
P I.5	Energy band profile of Al/HfO2/p-Ge MOS structures by XPS and electrical characterization	M. A. Botzakaki
P I.6	Electrical conductivity mechanisms and XPS analysis of Al/Ta2O5/p-Si MOS structures	M. A. Botzakaki
P I.7	Influence of high-temperature annealing on the hole transport and trapping properties of Al2O3/SiO2 dielectric stacks	V. Ioannou-Sougleridis
P I.8	The effect of thermal annealing on the structural and optical properties of CQD-based thin films	A. Segkos
P I.9	Growth of ZnO nanowires on seeding layers deposited by Atomic Layer Deposition: The influence of process parameters	A. P. Kerasidou
P I.10	"Applying power contributors method for leakage currents modeling of CMOS Cells"	S. Nikolaidis
P I.11	Electronic properties and magnetism of Si nanowires with non-magnetic doping and surface dangling bonds; a DFT approach	Francisco de Santiago
P I.12	Vacancies and boron doping in a zinc oxide monolayer: a DFT investigation	Francisco de Santiago
P I.13	Atomic Structure Investigation of Shockley Partial Dislocations in GaN Using Aberration-Corrected HRTEM	G. P. Dimitrakopulos
P I.14	Understanding Small Fe–Mo Perovskite-like Clusters	Eliel Carvajal
P I.15	Quantum confinement effects on the low temperature specific heat of silicon nanowires: a first principles study	Alejandro Trejo Baños

P I.16	Modelling of the effect of boron-vacancy centers on the electronic properties of diamond nanowires	Alejandro Trejo Baños
P I.17	Electronic properties of hydrogen passivated [001]-Si nanowire with interstitial Na atoms	Fernando Salazar
P I.18	A computational analysis of rare cell capturing within a microfluidic device with patterned herringbone grooves	G.Kokkoris and A. Tserepi
P I.19	Design of a Lab on a chip microfluidic device for DNA amplification	G.Kokkoris and A. Tserepi

Tuesday November 6th

9:00 **Welcome, registration**

9:30-10:40 Photonics, Lasers

Chair: N. Farmakis

T1

9:30	**Direct laser materials growth and processing for novel photonics**	**N.A.Vainos (Invited)**
10:00	A Ball Lens/LED micro-optical chip for imaging reflective surfaces	G.Korompili
10:20	On the negative photoconductivity in AlGaN/GaN heterojunction under sub-bandgap illumination	S.Gardelis

10:50-11:50 Magnetism and magnetic materials

Chair: E. Hatzikraniotis

T2

10:50	Ultrathin antiferromagnetic lms with tunable properties	A. Mandziak
11:10	Tuning of macroscopic magnetic features by magnetic field-induced nanoparticle self-assembly	E.Myrovali
11:30	Design of magnetic field configuration for spatially-focused heating of magnetic nanoparticles	N.Maniotis

11:50-12:05 Coffee break

12:10-13:30 Technologies for Energy harvesting and storage

Chair: A. Hatzopoulos

T3

12:10	Triboelectric generators: Influence of surface modification on electrical performance	C.Tsamis
12:30	Silicon nanoparticles enwrapped with graphene as anode material for Lithium ion batteries	D. -P. Argyropoulos
12:50	Electrochemical study and modelling of activated carbon cloth with reduced graphene oxide coating as electrode for supercapacitors	I.Gkionis
13:10	Advances in micro & nano-structured thermoelectric materials for energy harvesting applications	E. Hatzikraniotis

13:40-14:50 **Lunch break**

15:00-16:50 **Emerging Devices and Technologies**

Chair: N. Konofaos

T4

15:00	**Quantum computing with quantum walks**	**I.Karafylidis (Invited)**
15:30	Simulation of a Vacuum Transistor	M. Tsagkarakis
15:50	JFETLAB – An Online Simulation Tool for Double Gate Junction FETs	M. Bucher
16:10	Undermask penetration for different crystal orientations in 4H-SiC TSIVJFETs	K. Zekentes
16:30	Graphene monolayer treated with UV irradiation for large area FETs by optimized electron beam lithography	P. Dimitrakis

16:50-17:10 **Coffee break**

17:20-19:00 **Poster Session II**

Chair: D. Tassis, G. Dimitrakopulos

P II.1	Study of UTBB FD-SOI MOSFET transistors' degradation with TCAD simulation tools	D.Tassis
P II.2	Simple techniques for strain engineering of few layer MoS2 membranes	J. Parthenios

P II.3	Synthesis and spectroscopic study of two-dimensional WS2 crystals	J. Parthenios, K.Papagelis
P II.4	Weak Inversion Ring Oscillator Design Study in 65nm CMOS technology under Total Ionizing Dose Effects	A. Papadopoulou
P II.5	NiTi Memristive Behavior	S.G. Stavrinides
P II.6	Electrical characterization of Carbon Quantum Dots thin films	A. Segkos
P II.7	Comparison of impact ionization models for 4H-SiC, through breakdown voltage simulations in room temperature	D. Stefanakis
P II.8	Electrical characterization of metal/ a-SiC:H/Si MIS capacitors for DNA sensor application	F. Farmakis
P II.9	Substractive Plasma Nanoassembly: A technology for the fabrication of hierarchical structures	A. Smyrnakis
P II.10	Electrical Behavior of Commercial Discrete Power VDMOS Transistors and their Compact Modelling	N. Makris
P II.11	Accurate and complete nanometrology of lithographic pattern roughness: Recent challenges and advances	V. Constantoudis
P II.12	Multifractal analysis of nanostructured polymer surfaces during plasma etching	V. Constantoudis
P II.13	Optimization of ZnO nanowires for piezoelectric harvesters on flexible substrates	C. Tsamis
P II.14	VO_2 thin films prepared by reduction of PVD-deposited V_2O_5 on transparent substrates: Electrical, optical properties around SMT and relevant applications	D. K. Manousou
P II.15	Humidity protected Platinum nanoparticles strain sensor using alumina coating	V. Aslanidis
P II.16	Synthesis of copper ferrite and β-cyclodextrin graphene-based nanohybrids via hydrothermal and solvothermal methods	A.Zourou
P II.17	Influence of embedded nanoparticles on switching properties of bilayer metal oxide structures	D. Tsoukalas
P II.18	TCAD simulation and AC-analysis of the UTBB FD-SOI transistor for the estimation of the trans-capacitances	S. Manousaridis

20:00 **Conference Dinner**

Wednesday November 7th

8:45 **Welcome, registration**

9:00-10:30 Memories, MEMS, Sensors

Chair: N. Farmakis

W1

9:00	**Ultrafast Laser generated Rayleigh surface acoustic waves: physics and applications on material diagnosis**	**N.A.Papadogiannis (Invited)**
9:30	Stiffness correction method for improving vibrations immunity of a MEMS tuning fork gyroscope	A. Koumela
9:50	RRAM cells with Silicon Nitride as resistance switching layer	P. Karakolis
10:10	Acetone sas micro-sensors based on graphene nanoplatelets on flexible substrates	M.Georgas

10:30-10:50 Coffee break

10:50-12:40 Novel materials and applications

Chair: M. Gioti

W2

10:50	**Nonlinear electromagnetic metamaterials: mathematical analysis, physical phenomena, and engineering explorations**	**N.Tsitsas (Invited)**
11:20	Nanoperforation of graphene with pore diameters smaller than the diffraction limit of light	J. Parthenios
11:40	Controlled, scalable synthesis and growth-induced strain effects in single-layer MoS2 and WS2 crystals	A. Michail
12:00	Computational Analysis of a–Type Edge Dislocations Along <10-10> in GaN	S. Giaremis
12:20	Quantitative Characterization of Ultrathin $In_xGa_{1-x}N$/GaN Quantum Wells by HRSTEM	I.Vasileiadis

12:50-14:00	**Closing Ceremony**

12:50 **Plenary speaker**

Recent progress in nanoelectronics, C. Dimitriadis

13:30 **Closing remarks and award ceremony**

14:00-15:00	**Lunch**