EUROTRAINING

NANOTECHNOLOGY FOR ELECTRONICS

7-8 October 2013, UPB & IMT, Bucharest, Romania

COURSE PROGRAM

1st Day Program: 7th October, 2013
Course site: Campus Leu, Building B, Room 206

09:00-09:05 **Introduction**

09.05-10.45 **Delivery of two webcasts: Nanotechnology applications and trends**

Stephen J. Fonash "Nanotechnology Applications in Today's World„
http://elluminate.mesacc.edu/play_recording.html?recordingId=1277836648560_1285344098830

Stephen J. Fonash

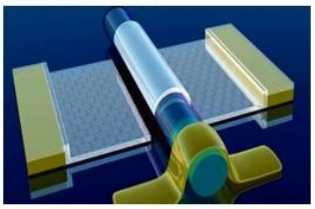
Bayard D. Kunkle Chair in Engineering Sciences, Director Center for Nano-technology Education and Utilization

The Pennsylvania State University

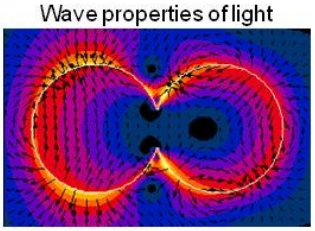
Abstract

Before taking a quick tour through some of today's applications of Nanotechnology, we must ask "what is so different about the nano-scale"? The answer is: small size – can get a lot of nano-things in an area or volume; most atoms are at the surface and their electron distributions are different than that of an isolated atom or that of the atoms in a bulk solid; wave properties of light become important for the small structures and nature allows some unusual chemical bonding for nano-scale structures. These opportunities available at the nano-scale should be and are used by engineers and scientists to make new materials and, from these new materials, come new devices and structures.

High-speed graphene transistor



Wave properties of light



Tom Morrow "Trends in Nanoelectronics: Microchips and More„
https://sas.elluminate.com/site/external/launch/nativeplayback.jnlp?sid=2012302&psid=2013-01-25.1007.M.13BC40C9350636C02C7F877AFA0927.vcr

Tom Morrow

Executive Vice President of Global Emerging Markets and Officer of Chief Marketing

SEMI global industry association

Abstract

The penetration of semiconductors into our everyday lives is accelerating, being driven by Moore's Law and Haitz's Law, the two most powerful economic and social forces of our time. Many of the same technologies and processes developed to make today's most advanced microchips are now being utilized in solar energy, LEDs (including Smart Lightning), MEMS, displays, printed, and large area electronics. Discover how nanotechnology and nanoelectronic innovations are driving today's commercial or high-reliability automotive electronics revolution and how they will shape our future.

LEDs, adaptive lightning

Printed electronics in action

10.45-11.00 Coffee break

11.00-13.00 **Delivery of two webcasts: Nanotechnology impact on the performance of electronics and materials**

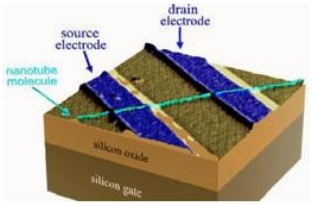
Osama Awadelkarim "How is Nanotechnology Changing the Electronics Industry?"
http://elluminate.mesacc.edu/play_recording.html?recordingId=1311874826010_1330102989559

Osama Awadelkarim
Associate Director, NACK
Professor of Engineering Science and Mechanics
The Pennsylvania State University

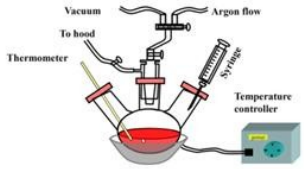
Abstract

For 50 years, electronics have run on silicon transistor technology. Over those years, that technology has continually been scaled down to the point now further shrinkage is difficult. Continuing evolution of electronics beyond the limits of the conventional silicon technology (top-down approach, lithography technology) requires innovative approaches for solving heat dissipation, speed and scaling issues. Many people have suggested that the microelectronics industry has to stop using top-down nanofabrication and must move to bottom-up or hybrid nanofabrication. If this worked, it would stop the spiralling costs of producing nano-scale transistors.

Carbon Nanotube Transistor



Synthesis of Quantum Dots



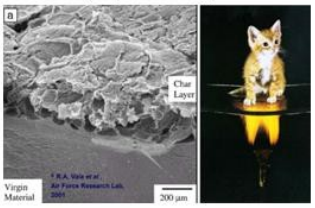
Allen Kimel "Nanotechnology Impact on Materials Properties and Performance„
http://elluminate.msacc.edu/play_recording.html?recordingId=1311875023430_1335458131773

Allen Kimel
Assistant Professor, Associate Head for Undergraduate Studies
The Pennsylvania State University – Materials Science and Engineering

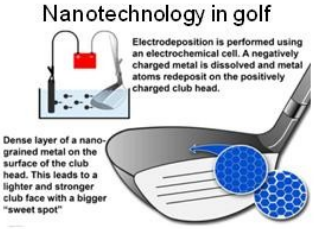
Abstract

By using structure at nanoscale as a tuneable physical variable, we can greatly expand the range of performance of existing chemicals and materials. For example, ceramics, which normally are brittle, can easily be made deformable when their grain size is reduced to the low nanometre range. Switching devices and functional units at nanoscale can improve computer storage and operation capacity by a factor of a million, while nanostructured metals have greatly improved mechanical properties, both in ductility and strength. That is the reason why nanotechnology has attracted large amounts of funding, research activity and media attention.

Thermal properties improvement



Nanotechnology in golf



13.00-13.45 Lunch break

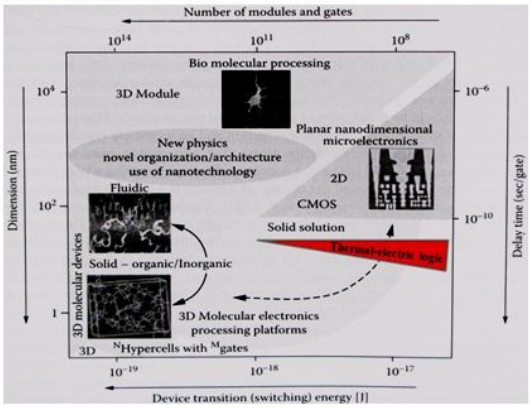
13.45-15.00 **Nanotechnology – novel devices, applications and trends**
Presentation of an invited renowned scientist

János Mizsei: „Electronics, microelectronics, nanoelectronics, ..."

János Mizsei
CSc, PhD, DSc
Professor
Head of the Semi-conductor Laboratory
Department of Electron Devices
Budapest University of Technology and Economics
www.eet.bme.hu/staff/run/en/id/mizsei

Abstract

Until now, the continuous development of electronics has been characterized by Moore's law. The scale down resulted in the nanosized CMOS integrated circuits, pushing the "red brick wall" towards the lower dimensions. On the other hand, there are many new ideas for building atomic or molecular scale devices for the information technology. However, there is still a gap between the up-to-date "top-down" CMOS technology and the "bottom-up" devices, i.e. molecular electronics, nanotubes, single electron transistors. The new thermal-electric device (phonsistor) and the CMOS compatible thermal-electric logic circuit (TELC) may help to fill this gap.



15.00-15.15 **Coffee break**

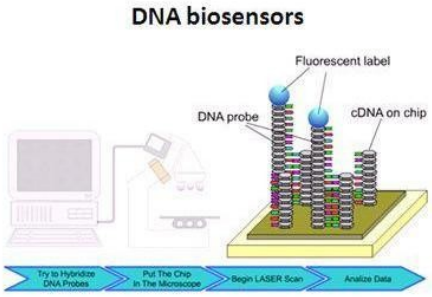
15.15-16.30 **Applications of nanotechnology**
Presentation of a young East European scientist

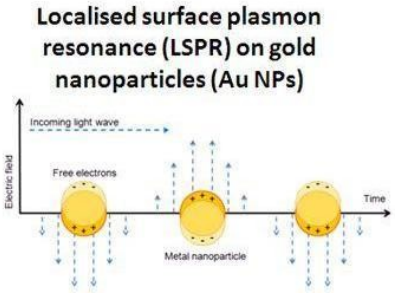
Attila Bonyár: "Enhancing Biosensors with Nanotechnology"

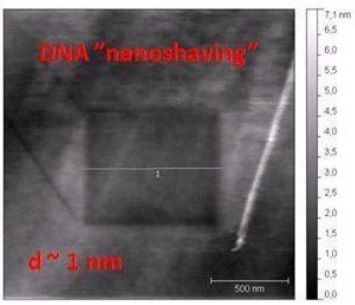
Abstract

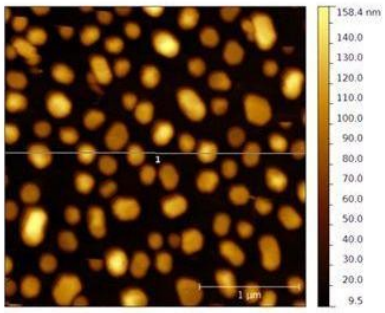
Biosensors applying nanoscale biomaterials such as DNA molecules as sensing elements possess great potential in the fields of disease diagnostics, environment monitoring or in pathogen detection. The optimization of sensor properties (such as sensitivity or limit of detection) is a constant challenge in this multi-disciplinary field. Signal amplification methods, including the application of nano-materials or nano-patterned surfaces for surface plasmon resonance imaging (SPRi); and novel atomic force microscopy (AFM) based nanotechnology tools and investigation methods are in the focus of this presentation.

Attila Bonyár
Assistant Professor
Department of Electronics Technology,
Budapest University of Technology and Economics









16.30-16.45 Coffee break

16.45-17.30 **Problem solving discussion** –
with the participation of the invited renowned scientist, the young East-European presenter, industrial experts and the EuroTraining delegates.

2nd Day Program: 8th October, 2013
Course site: Campus Leu, Building B, Room 206

08.30-09.15 **Presentations about nanotechnology equipment development**
Presentation of an industrial expert from Raith, Germany

Martin Kirchner: “Instrumentation and processing with electron and ion beam lithography”

Martin Kirchner
Sales Director New Markets
Raith GmbH
Dortmund/Germany

Abstract:

Electron and ion beam lithography are enabling technologies for research and development in many fields of nano technology. The presentation reviews the basics of both technologies. Emphasis is given on instrumentation and processing which is useful in academic or industrial research and in small batch production. Application results from recent years are presented stemming from various disciplines including Electronics and Photonics.

The presenter is with Raith, a high tech company headquartered in Dortmund, Germany. Since two decades Raith instruments are extensively used within the nano fabrication and nano engineering community. Raith made conventional electron beam lithography accessible to a broad research community worldwide. In February 2013 Raith acquired Vistec Lithography who is known for more than 40 years of experience in the field of electron beam lithography under the brands of Philips, Cambridge Instruments and Leica.

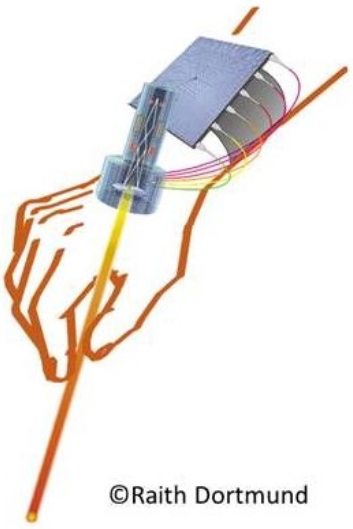


Figure symbolizes a focused charged particle beam structuring substrates at nano scale.

09.15-10.00 **Presentations about current research results**
Presentation of scientists about up-to-date research results

Detlef Bonfert, Ciprian Ionescu: “Electronic Conductive Layers containing Nanoparticles”, including “Sensing Properties of Carbon Nanotube-Polymer Layers on Foils”

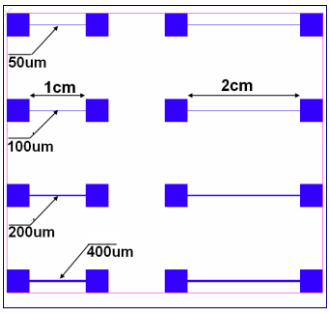
Presenter & Co-Author:

Ciprian Ionescu
PhD, Associate Professor
Center for Technological Electronics and Interconnection Techniques, University Politehnica of Bucharest, Romania

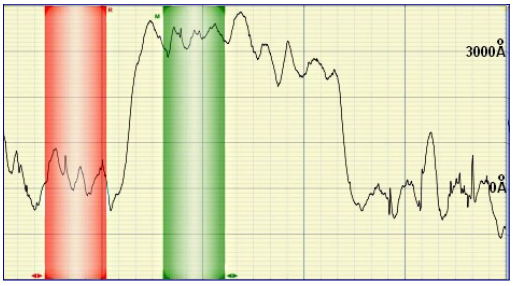
Abstract:

The presentation will be focused on different layers with interesting properties for electronic packaging. The first part will present the investigations on thick films based on carbon nanotubes that were screen printed on different foils. The obtained resistive layers were first electrically characterized, revealing the negative temperature coefficient of resistance (TCR) of the layer. A similar resistance decrease is obtained by irradiating the layer with an IR laser. The measurements reveal the temperature and IR-laser sensing properties of the layers. (See below for more details.)

The second part presents the results of inkjet printing using a material with silver nanoparticles. The printed tracks is are realized on Kapton Polyimide foil and PEN foils which can sustain a temperature reaching 180 degrees Celsius, required for ink curing during at least 30min, see figure. Another set of investigations was done on silver tracks with larger width 1-4 mm in order to determine the current carrying capabilities.



Layout of the inkjet printed structures.



Thickness profile of the tracks.

Co-Author:

Detlef Bonfert

PhD, Senior Researcher

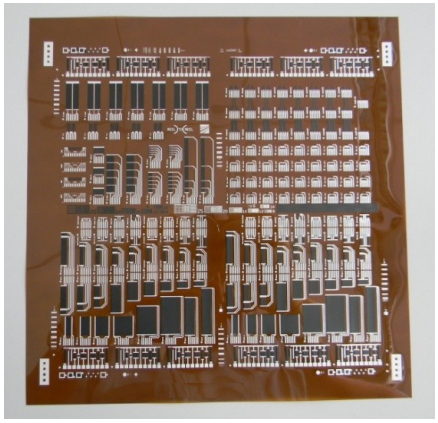
Fraunhofer Research Institution for Modular Solid State Technologies (EMFT), Munich, Germany,

Abstract:

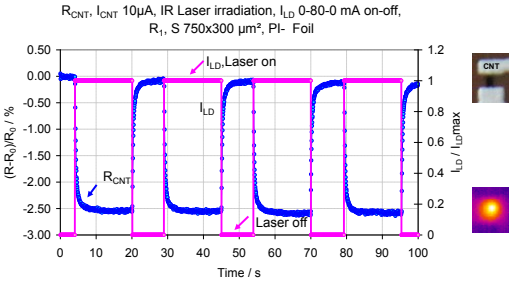
Sensing Properties of Carbon Nanotube-Polymer Layers on Foils:

Carbon nanotubes (CNT) have remarkable electrical, mechanical, thermal and optical properties. CNT-polymer composites are therefore alternative materials for applications, like flexible electrodes in displays, electronic paper, antistatic coating. But these materials can also be used as sensors, due to their special properties. In the presentation we underline the behaviour of CNT-based thick film layers on foils due to electrical, mechanical, thermal and optical stimuli. Possible applications as sensors materials are further described.

Carbon nanotubes with their remarkable properties are unique materials which offer a wide range of promising applications. Combining CNT's with polymers give a new class of easy processing materials with sensing properties. These materials can be applied on polymer foils, on paper, on stretchable materials and on textiles, using the screen printing technology. This technology was used in a roll-to-roll process to realize CNT-based thick film layers on foils in order to characterize some of their mentioned unique properties.



Reel to reel screen printed test structures.



DC resistance during IR- laser irradiation (λ=1310 nm), laser current 80 mA, resistor current sampling at 10 µA, CNT thick film on foil.

10.00-10.15 **Coffee break, preparation for the laboratory visit**

10.15-12.00 **Practical demonstration and laboratory visit**

Visit site: Campus Grozăvești, Building JK, Rooms: 010, 011, 209, and 211

Visit to the Department of Metallic Materials Science and Physical Metallurgy and the Biomaterials Research Centre (BioMat http://www.biomat.ro/) at the Materials Science and Engineering Faculty, University POLITEHNICA of Bucharest.

Presenter & Head of Thermophysical Testing Laboratory:

JK 211

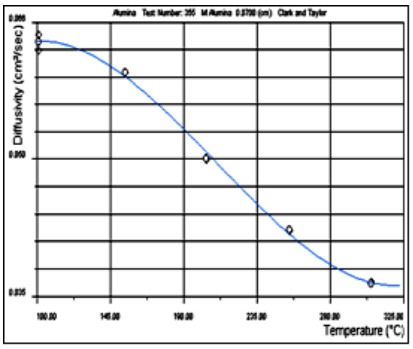
Mihai Brânzei

PhD, Associate Professor,

Department of Metallic Materials Science & Physical Metallurgy

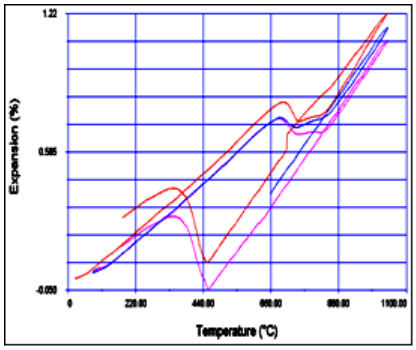
(BIOMAT)

FlashLine™ 3000 - Thermal Properties Analyzer



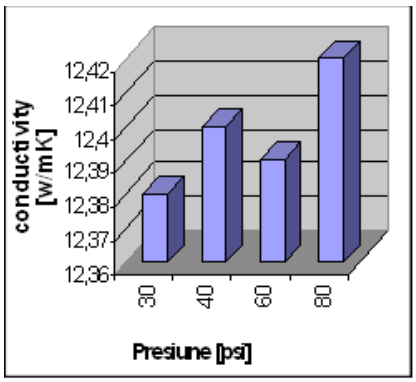
- ✓ The flash method is absolute in nature (it requires no transfer standard for calibration).
- ✓ For specific heat capacity testing, the use of one reference is a necessity. All references are supplied with appropriate certificate and installable data file.
- ✓ Using special sample fixtures, pastes, films, liquids, and samples through melting can be tested.

Unitherm™ 1161V - High Temperature Vertical Dilatometer



- ✓ Digital displacement transducer requires no periodic calibration requirements.
- ✓ Allow softening point determination and controlled rate sintering cycles.
- ✓ System correction for the tube is automatically made in software.
- ✓ Specific pushrod loading can also be applied through additional weights on a pan

QuickLine 10C – Thermal Conductivitymeter



- ✓ Guarded Heat Flow Meter Method.
- ✓ Metals, ceramics, polymers, composites, glass, and rubber can be tested accurately.
- ✓ Has been programmed with 8 reference materials covering an approximate thermal conductivity range of 0.1-220 W/mK.
- ✓ Ambient temperature operation at different pressure level (max. 8barr).
- ✓ Thin samples like paper products and plastic films can also be tested.

Presenter & Head of Materials Characterisation and Analysis Laboratory

JK 011

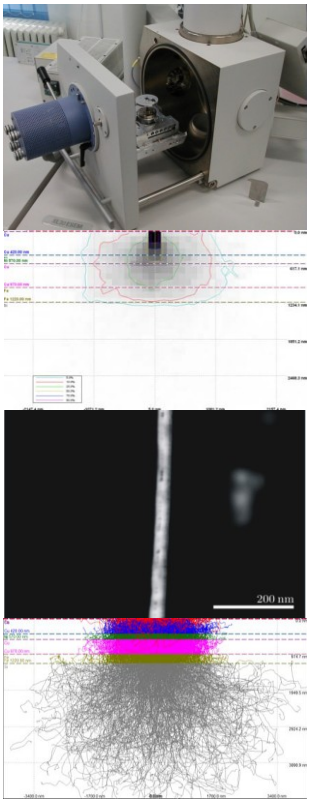
Florin Miculescu

PhD, Associate Professor

Department of Metallic Materials Science & Physical Metallurgy

(BIOMAT)

Scanning electron microscopy (SEM) and energy-dispersive X-ray microanalysis (EDS) are used extensively in nanotechnology and thin films for electronics. When assessing nano dimensional multilayer systems, by SEM and EDS, new standards of accuracy are required for the analytical data generated by the electron-matter interactions from substrate and the effective thickness of deposited ultrathin films. We investigated the effect of SEM electron beam energy on the penetration depth on GMR effect Cu-Ni-Cu-Fe-Ta nano-layered structures with various thicknesses. The samples were deposited onto Si (100) wafers by thermo-ionic vacuum arc. We used extensive micro-analytical SEM-EDS measurements and mathematical simulations based on Monte Carlo model. Relationships between the electron beam energy and penetration depth into samples were established. Elemental chemical analyses and films' thickness measurements are performed and the influence of the accelerating voltage of electron beam upon the size and shape of the interaction volume is studied and discussed accordingly.



Presenter & Head of Electrochemistry Laboratory

JK 206

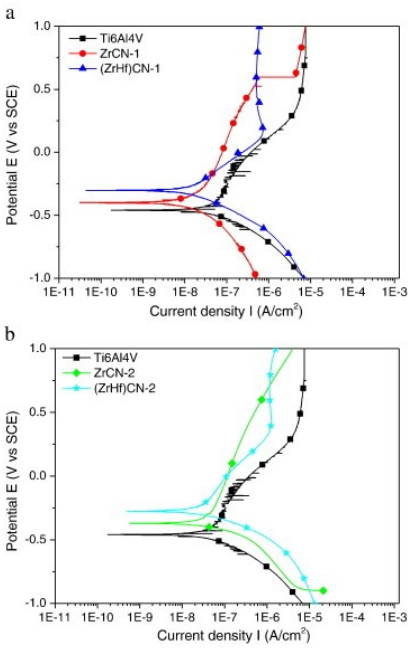
Cosmin Cotruț

PhD, Lecturer, Dept. of Metallic Materials Science , Physical Metallurgy

(BIOMAT)

The Electrochemistry Laboratory is a new research laboratory establish in May 2013 that deal with almost electrodeposition, electrochemistry or electrosynthesis techniques.

The research at the Laboratory centres on understanding and control of the response of the surface structure and physical chemistry when driven by dynamic environments of chemical reactivity. Main research domains of laboratory are: Corrosion, Sensors, Batteries and Fuel Cell, Nanotechnology



12.00-12.30 **Farewell coffee with discussion and course evaluation**

12.30 **Disperse**

Further information / contact persons:

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Dr. Zsolt Illyefalvi-Vitez (illye@ett.bme.hu tel: +36 1 4632753)
Budapest University of Technology and Economics,
Department of Electronics Technology, Hungary