

SECTOR DIALOGUES EUROPEAN UNION - BRAZIL

REPORT

PHOTONICS AND NANOTECHNOLOGY INNOVATIONS FOR MEDICAL DEVICES



 **Dialogues**
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PHOTONICS AND NANOTECHNOLOGY INNOVATIONS FOR MEDICAL DEVICES



June 2018

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EXECUTIVE SUMMARY



The Sector Dialogues are a cooperation instrument between the European Union and Brazil, based on the principles of reciprocity, complementarity, and mutual interest, which is founded on the exchange of expertise, experiences, and best practices of technical and/or political nature on themes of shared interest.

The Initiative is jointly undertaken by:

- The Office of Management for the Ministry of Planning, Development and Management (MP);
- The Delegation of the European Union to Brazil (DELBRA); and,
- The Ministry of Foreign Affairs (MRE).

During the 9th Call of the Sector Dialogues, the General Coordinator of Development and Innovation in Converging and Enabling Technologies (CGTC) – which is part of the Department of Policies for the Development and Innovations in Structure Technologies (DETEC), with the Office of Technological and Innovation Development (SETEC) – has been assigned with the project “Sector Dialogue of Photonics and Nanotechnology Innovations for Medical Devices”, within the Information Society Dialogue.

The main objective of this project was to gather practical knowledge to build public policies that might prompt and promote innovative and technological development in Photonics. The proposal also aimed at setting a cooperation between ecosystems related to the Photonics, and Nanotechnology to build innovative solutions in products, processes, and systems, in addition to prompting for 2+2-type of projects.

Yours sincerely,

Leandro Antunes Berti

General Coordinator of Development and Innovation in Converging and Enabling Technologies – CGTC; Department of Policies for the Development and Innovations in Structure Technologies – DETEC; Office of Technological and Innovation Development – SETEC; Ministry of Science, Technology, Innovations and Communications- MCTIC



ROLE OF THE TECHNOLOGICAL PLATFORMS: PHOTONICS 21 AND EPOSS




The European industry includes top-notch players in nanotechnology, and photonics fields. These companies lead the investigations and global innovations in many different fields. However, technological innovation advances require a broader strategical alignment to include the world surrounding businesses, research centres, and universities. This involves creating conditions for a more effective way to allocate resources not only within the private sector, but in the public sector as well.

Aiming to promote a broader cooperation, the European Committee has launched the European Technology Platforms (ETPs) to prompt for the external creation by adding companies, research centres, and universities across strategical industrial sectors. Said “platforms” have a key role in the dialogues with the European Committee regarding the priorities set forth in the Horizon 2020 European program, which was reflected in the introduction of a research strategical agenda that serves as the foundation for the preparation of the annual work programs. Furthermore, the technological platforms aim to develop a set of additional measures to explore more efficiently the innovative potential of the outcomes of the research studies through the development of new products and services, with special focus on the value chains across different areas of interest.

Two technological platforms have stood up as evidently relevant for this project: Photonics 21 and EPOSS.

The Photonics 21 ETP brings along 2.500 entities from all over Europe, whose shared goal is to discuss and explore the unlimited possibilities of light technology within a broad range of technological areas such as chips, lighting, health and life sciences, space or in the automotive sector. By the way, health and life sciences is one of the most dynamic sectors and constitutes an independent work group. This sector has been dedicating to identify the challenges, and the opportunities photonics offers to develop new methods for early, and non-invasive diagnosis, mainly for age-related and lifestyle-related health conditions. Among the most promising technologies are the use of multi-frequency light (X-rays, ultraviolet, infrared, Terahertz), spectroscopy, and endoscopy devices.



The EPOSS ETP focuses on the integration of intelligent systems involving Micro, and Nano-systems. These are essential technological capabilities to develop new products, and services enabling the combination of cognitive functions with sensors, artificial vision, power management, data processing and communication. Such functions involve contributions from so many different fields, e.g., nanoelectronics, micro-electro-mechanics, photonics, physics, and chemistry. Again, the applications within health, and medical devices area undertake a key role.

The engagement of PHOTonics21, and EPOSS EPTs in the various events set up for the project has enabled a more effective networking among Brazilian and European players from research, and innovation markets in Brazil, thus creating conditions for a more effective internationalization of the Brazilian competences in these areas.

Yours sincerely,

Carlos Oliveira

*Minister-Counsellor
Head of Information Society and Media Sector
Delegation of the European Union to Brazil - DELBRA*

THE PROJECT



The initiative of the Sector Dialogues provides Brazil and the European Union with an opportunity to discuss on the main advances related to public policies for Converging and Enabling Technologies, specially Photonics. It has established a cooperation basis for the innovation in Photonic ecosystems, aimed at strengthening not only Science and Technology, but also companies' approach to innovation.

In the scope of the Sector Dialogues' Project, the 1st Meeting of Innovation in Photonics and Nanotechnology for Medical Devices was held in Campinas/SP, in Brazil, aimed at briefing the European partners on the main actions in Photonics and Nanotechnology Innovations, as well as taking them to technical visits to major Brazilian laboratories: Centro de Pesquisa e Desenvolvimento em Telecomunicações (CPqD [Telecommunications' Research and Development Centre]); Centro de Componentes Semicondutores (CCS [Semiconductors' Components Centre]), Universidade Estadual de Campinas (UNICAMP [State University of Campinas]); Laboratório Nacional de Nanotecnologia (LNNano [National Lab of Nanotechnology]) and Laboratório Nacional de Luz Síncrotron (LNLS [Synchrotron Light National Lab]), in the Centro Nacional de Pesquisa em Energia e Materiais (CNPEM [National Centre of Research in Energy and Materials]); and Centro de Tecnologia da Informação (CTI) Renato Archer [Renato Archer Information Technology Centre].

Later, a technical mission headed to Europe to visit reference institutions in Photonics, and to promote the integration between Brazilian and European experts, in the innovation fronts within Photonics and Nanotechnology. They visited the INL (International-Iberian Lab of Nanotechnology), in Braga/Portugal, and the IMEC (Interuniversity MicroElectronics Center), in Leuven/Brussels.



Opening Ceremony

INNOVATION WORKSHOP IN PHOTONICS AND NANOTECHNOLOGY FOR MEDICAL DEVICES IN THE SCOPE OF THE SECTOR DIALOGUES

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The Ministry of Science, Technology, Innovations, and Communications (MCTIC) set up a workshop on Innovation and Nanotechnology Innovations for Medical Devices to diffuse the Brazilian competence in Photonics, and to promote the interaction with the European partners. The event occurred between November 30 and December 1st, 2017, at the CPqD (Telecommunications Research and Development Centre).

The workshop promoted the integration among the institutions and the research groups in Brazil and aimed at cooperating with the European Union. The workshop was split in two parts: the first one comprised of the Opening Ceremony and speeches on the theme, and the second part comprised of technical visits to key laboratories of the area.

The Opening Ceremony was attended by Dr. Leandro Antunes Berti, representing the SETEC (office for Technological and Innovation Development) of the Ministry of Science, Technology, Innovations and Communications (MCTIC); Engr. Carlos Oliveira, Minister-Counsellor, Head of the Information Society and Digital Market Sector of the Delegation of the European Union to Brazil (DELBRA); and Dr. Alberto Paradisi, representing the CPqD (Telecommunications Research and Development Centre).

Speeches were given by several experts in Photonics.

Dr. Leandro Antunes Berti, General Coordinator of the Converging and Enabling Technologies General Coordination (CGTC), introduced the 2016-2022 Science, Technology and Innovation Action plan for Converging & Enabling Technologies.

Engr. Carlos Oliveira, who represents the Delegation of the European Union to Brazil, and as the contact person with DG CONNECT, emphasized the relevance of the cooperation between Brazilian and the European Industry – not only regarding the research domain, but also as to the future development of applications that could affect the lives of the citizens, and in the creation of jobs.

Dra. Petra Weiler, who represents EPOSS ETP, and VDI/VDE Innovation +Technik GmbH, featured the theme 'Activities for Intelligent Systems, electronic devices, and health'.

Dr. Alberto Paradisi, Vice-President of Research and development of the Research and Development Centre in Telecommunications, talked about the main capabilities, and activities of the CPqD in integrated Photonic.

Dr. Paulo Freitas, Director-General of the International-Iberian Laboratory of Nanotechnology (INL), in Braga/Portugal, talked about the main activities of INL.

Dr. Anderson Stevens Gomes, with the National Institute of Photonics of the Federal University of Pernambuco State (UFPE) described the main scientific activities of the National Institute of Science and Photonics Technology (INFO), with emphasis in biophotonics.

Dr. Manuel Steidle, Director of Technology of the CERTI Foundation, presented cases on the application of photonics for the development of solutions for the health, consumer goods, aerospace, and defence segments.

Dr. Linas Eriksonas, who represents the Photonics21 ETP and LITEK spoke about their company's main activities.

Dr. Fabricio K Marchini, Researcher, and Executive Manager for the IBMP technological development, talked about the main activities of the Molecular Biology Institute of Paraná State (IBMP).

Dr. Roberto Panepucci, Researcher of the CTI Renato Archer, talked about their capabilities in microfabrication of Micro /Nano electronic, and photonic devices on wafers and flexible substrates, using traditional microelectronic techniques, and new techniques for the production and integration of nanoparticles and new materials into rigid/flexible substrates.

You will find below the complete summary of the speeches and the contact information for the experts.

The second part of the event included technical visits to:

- The Optics Laboratory of the CPqD (Telecommunications Research and Development Centre) and to BrP (BrPhotonics);
- The CCSNano (Semiconductors and Nanotechnology Components Centre) () at UNICAMP;
- The LNNano (National Laboratory of Nanotechnology), and the LNLS/SIRIUS (National Laboratory of Synchrotron Light) () at the CNPEM;
- The typification, and qualification laboratories of microelectronic components (NAPE, and NMS), micro and Nano-production (NMS and NMI) of materials from devices and packaging (formerly NEE), and of photonics with the Information Technology Centre Renato Archer.

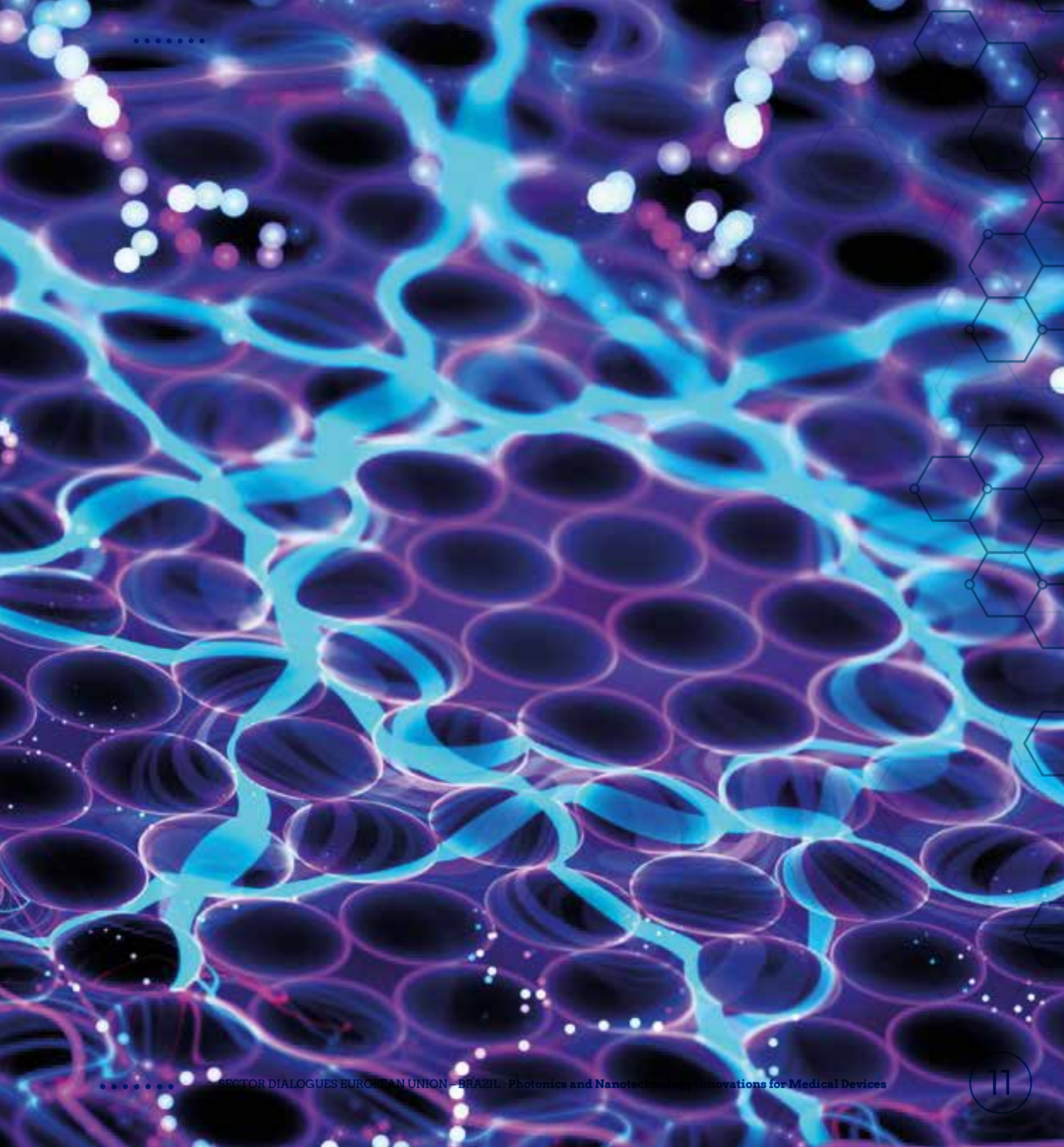
The Workshop aimed at prospecting niches of operations in Photonics among Europeans and Brazilian partners, and at creating future partnerships/projects to be developed among institutions, and participants in the Sector Dialogues.

Attending the event there were representatives from Europe, the Federal Government, Laboratories from the National System of Nanotechnologies Labs (SisNANO), the Third Sector, universities, research units from the MCTIC, the Brazilian Academy of Sciences, and the Consulate of Lithuania.



1st Meeting of Innovation in Photonics and Nanotechnology for Medical Devices in the scope of the Sector Dialogues

SUMMARY OF THE SPEECHES





SCIENCE, TECHNOLOGY, INNOVATION ACTION PLAN FOR CONVERGENT AND ENABLING TECHNOLOGIES 2016 - 2022



DR. LEANDRO ANTUNES BERTI

MINISTRY OF SCIENCE, TECHNOLOGY, INNOVATIONS, AND
COMMUNICATIONS - MCTIC

The General Coordination of Converging and Enabling Technologies (CGTC) of the Ministry of Science, Technology, Innovation and Communications (MCTIC), presented the Science, Technology and Innovation Action Plan for Convergent and Enabling Technologies, as a proposal for State Policy, linked to the National Strategy for Science, Technology and Innovation ENCTI 2017-2022. In this occasion it would be presented the planning of public policies to encourage the sustainable development of Nanotechnology and Photonics, as well as their interactions for the creation of innovative diagnostic devices and medical therapies.

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Petra Weiler



SELECTED ACTIVITIES IN SMART SYSTEMS, ELECTRONICS, HEALTH



PETRA WEILER

FUTURE TECHNOLOGIES AND EUROPE / VDI/VDE INNOVATION
+ TECHNIK GMBH


The presentation introduced:

- *VDI/VDE Innovation + Technik GmbH, see <https://www.vdivde-it.de/>;*
- *The spectrum of technologies and topics, the activities and structure of EPoSS, the European Technology Platform on Smart Systems Integration, see <http://www.smart-systems-integration.org>; and*
- *The ECSEL JTI (Joint Technology Initiative on Electronics Components and Systems for European Leadership), see <http://www.ecsel-ju.eu/>.*

Further to this, relevant application experiments from the EU-funded Innovation Action “SMARTER-SI - Smart Access to Manufacturing for Systems Integration” were presented, a project on the cooperative foundry of Smart Systems, see <http://www.smarter-si.eu/>. Another focus was on tools and results from the EU-funded Coordination and Support Action “inSSight - In-depth support for innovation and exploitation in Smart Systems Integration”, see <http://inssight.eu>, i.e. capability radar, investment game, and selected showcases.

Additionally, information was provided on EC funding and project portfolios in Smart Systems, Large Area Electronics and Nanoelectronics.

Finally an overview of the EU landscape in healthcare was given, focussing on ESTHER, an industry-driven initiative on Emerging and Strategic Technologies for Health-



care, and the Nanomedicine Translation Hub, see <http://www.enatrans.eu/public/nano-medicine-translation-hub>.

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Future Technologies and Europe
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10623 Berlin – Germany



Dr. Alberto Paradisi



PHOTONIC TECHNOLOGIES AT CPQD



DR. ALBERTO PARADISI

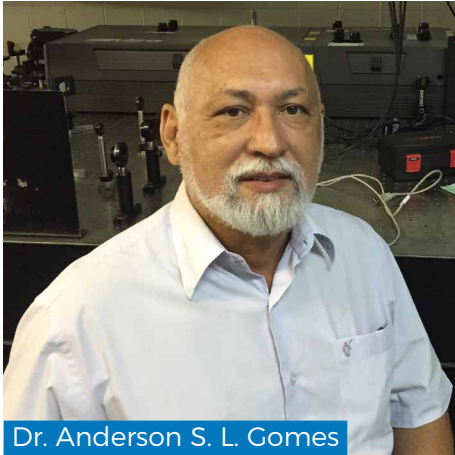
TELECOMMUNICATION RESEARCH AND
DEVELOPMENT CENTER (CPQD)

Alberto Paradisi presented the main capacities and activities of CPqD in the field of Integrated Photonics, highlighting the main technology results, patents and publications in the main international conferences – The Optical Network and Communication Conference & Exhibition (OFC); European Exhibition on Optical Communications (ECOC); and The International Conference on Optical Fiber Sensors (OFS) – and the transfer technology for the industry.

Contacts: Alberto Paradisi

Vice President of Research and Development of CPqD

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Dr. Anderson S. L. Gomes



THE NATIONAL INSTITUTE OF PHOTONICS: SCIENTIFIC ACTIVITIES



DR. ANDERSON STEVENS LEONIDAS GOMES

NATIONAL INSTITUTE OF SCIENCE AND TECHNOLOGY OF PHOTONICS
(INFO)/ FEDERAL UNIVERSITY OF PERNAMBUCO (UFPE)

In this presentation, I described the main scientific activities of the National Institute of Science and Technology of Photonics (INFO), with emphasis on the activities of biophotonics, the main theme of the sectorial meeting. In addition, some subprojects from the INFO were highlighted in the areas of nonlinear photonics and optomicrofluidics. Some recent results were presented in the topic related to biophotonics, such as nanothermometry, use of silver nanoparticles as nanolarvicides to eliminate *Aedes aegypti* larvae, ELISA platform with microfluidics, photodynamic inactivation and optical coherence tomography applications in dentistry and rheumatology.

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APPLICATION OF PHOTONICS IN THE DEVELOPMENT OF INTELLIGENT SYSTEMS



DR.MANUEL STEIDLE

CENTERS OF REFERENCE IN INNOVATIVE TECHNOLOGIES (CERTI)

The lecture given by CERTI in the Workshop: “Sectorial Dialogue of Innovation in Photonics and Nanotechnology for Medical Devices” on 30.11.2017 presented applications of photonics in the development of solutions for health, consumer products, aerospace and defense sectors. It was highlighted the innovation process practiced by the CERTI Foundation and the collaborative work model with the photonics, nano and biotechnology sectors for the development of intelligent systems. With emphasis on the cooperation project Cnpq-Fp07 Poditrodi, a platform for rapid testing of Chagas’ disease in portable devices, was illustrated as case how to collaboratively conceive and manage the development of relevant solutions for society, economy and environment.

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Director Mechatronics and Optics CERTI Foundation

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PHOTONICS FOR HEALTH: A CASE FOR CROSS-SECTORIAL INNOVATION: CHALLENGES AND OPPORTUNITIES



LINAS ERIKSONAS

LASER AND ENGINEERING TECHNOLOGY CLUSTER (LITEK)

The presentation has provided an overview of the photonics sector in Europe and presented Photonics 21, a technology platform bringing together the photonics community in the EU. A special focus was given to highlight the challenges facing the application of photonics technologies in the medical field. Issues such as market specifics, intellectual property, regulatory environment, and product development life cycles have been noted as being the key differentiators between photonics and medical technology fields. Further, the European Cluster Partnership in Photonics for Health LASER-GO was introduced and the LASER-GO approach towards creating value added alliances between SMEs and research organizations was discussed and exemplified by showing specific success cases.

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Dr. Fabrício K. Marchini



TECHNOLOGICAL DEVELOPMENTS WITH POTENTIAL USE OF PHOTONICS AT FIOCRUZ AND IBMP



DR. FABRICIO K. MARCHINI

MOLECULAR BIOLOGY INSTITUTE OF PARANÁ (IBMP)

The Molecular Biology Institute of Parana (IBMP), with more than 15 years of experience, is responsible for the production and supply, of the amplification module of Kit NAT HIV (AIDS), HCV (hepatitis C) and HBV (hepatitis B) and the ZDC Molecular Kit (for identification of Zika Virus, Dengue and Chikungunya) both from Bio-Manguinhos / Fio-cruz. IBMP has state-of-the-art laboratories and equipments, but above all, highly qualified human resources in the areas of Management, Production, Quality, Technological Development, Engineering and Logistics. In addition to integrating the FIOCRUZ system, thus incorporating all the potential of the scientific and technological relationship of this interaction. These institutions are among the leading biomedical and medical research institutions in Brazil. With all this context the IBMP one of its focuses, is the technological development and the search for technological consolidation for Brazil that culminate in high quality biotechnological products, so photonics is of great interest, because it is an area that is associated to the equipment and could help to develop even new areas."

Contacts: Fabricio K. Marchini

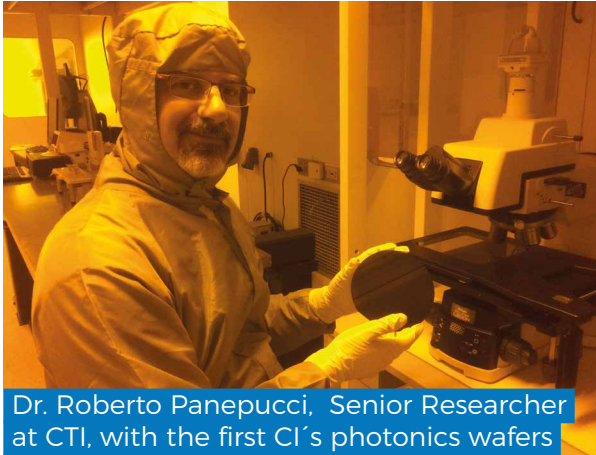
Public Health Researcher Carlos Chagas Institute - Fiocruz of Parana State

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Dr. Roberto Panepucci, Senior Researcher at CTI, with the first CI's photonics wafers manufactured in CEITEC S.A.



MICRO/NANO PHOTONIC DEVICES IN BIOMEDICAL APPLICATIONS



DR. ROBERTO PANEPUCCI

RENATO ARCHER INFORMATION TECHNOLOGY CENTER
(CTI RENATO ARCHER)

The competencies of the Renato Archer ITC are presented in the microfabrication of micro / nano electronic and photonic devices in wafers and flexible substrates, using traditional techniques of microelectronics, as well as new techniques for the production and integration of nanoparticles and new materials in rigid as well as flexible substrates. The encapsulation of micro / electronic nanodevices is presented, as well as advances in the encapsulation of photonic devices. The competencies in testing and characterization of electronic and photonic devices are presented. Specific cases of the application of these competencies are shown for:

- (1) optogenetic compatible neural probes;
- (2) waveguide microgrippers;
- (3) Optical interconnections between photonic ICs and the design of these ICs;
- (4) prototyping of photonic devices in polymers.

The availability for partnerships in R & D & I in the area of photonics applied to biomedical applications is presented.

Contacts: Roberto Panepucci, Pesquisador Titular,
Coordinator of Conception of Hardware Systems Division.

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TECHNICAL VISITS



TELECOMMUNICATION RESEARCH AND DEVELOPMENT CENTER (CPQD)

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The visit began with a presentation by the researcher Giovanni Beninca de Faria. In the first part of the presentation, a general overview of the photonics team in CPqD was shown, detailing the main results, technological transfers and available infrastructure. The next part was about the main capabilities of the photonics team, from design to chip layout and verification, and finally, optical and optoelectronic packaging. In the following, a detailed view of the ongoing projects on telecommunication devices was presented. The main topics were light emission (lasers), optical amplification and electro-optical modulation, highlighting the ability to perform a whole cycle of device design, from design to system validation. Visits were made to the Laboratory of Reconfigurable Optical Systems (LASOR), the Optical Transport Technologies Laboratory and the Photonic Integration Laboratory (cleanrooms class 100 and 10,000 with a total size of approximately 200 m²).



Dr. Giovanni Beninca de Farias

Contacts: Giovanni Beninca de Farias
Senior Research Engineer at CPqD

E-mail: gfarías@cpqd.com.br

THE SEMICONDUCTORS AND NANOTECHNOLOGY COMPONENTS CENTRE (CCSNANO/ UNICAMP)

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Semiconductors and Nanotechnology Components Centre (CCSNano) – visit on 12/01/2017

The tour was preceded by a presentation by Professor Dr. Stanislav Moshkalev, Director of the Semiconductors, and Nanotechnologies' Components Centre (CCSNano), a supplementary entity for the State University of Campinas (UNICAMP), which reports to the Coordination of Interdisciplinary Research Centres and Groups.

The overall purposes of the Centre are to perform basic and applied research, rendering services and offering education support focused on the continuous improvement of the personnel and processes in Micro/Nanofabrication and related areas, including microelectronics, nanophotonics and new materials.

The mission of CCSNano is to become a multidisciplinary, and multiuser reference-centre in Latin America, aimed at developing quantitative, basic, and applied research in:

- microelectronics;
- microfluidics;
- microsystems;
- nanophotonics;
- 0D, 1D, 2D, and hybrid materials;
- Micro and Nanofabrication techniques;
- Nanomaterial-based devices: mechanical sensors, chemical, biomedical, actuators, heaters, supercapacitors, and batteries.

The CCSNano infrastructure comprises approximately 20 large and medium-sized equipment and systems, installed in a 700 m² cleanroom, including an electron beam-driven lithographic system, optical lithography, double beam (FIB), electronic scanning microscopes, various plasma sources for thin-film corrosion and deposition, Raman, XPS, among others. Nowadays, the Centre serves over 60 users from different departments of UNICAMP, including the Physics and Chemistry Institutes; Electrical and Computing, Mechanical, and Chemical Engineering Departments; Technology Department, and external institutions like USP, UFSCar, UFMG, CTI Renato Archer, UNESP, UFRGS, UFTM, and Mackenzie.

CCSNano currently plays a leading role in micro and nanotechnologies, acting as a connecting bridge among dozens of emerging, and well-known research centres, educational institutes, and national technology companies. The list of companies developing projects with the CCS cooperation is increasingly growing, and includes Nacional de Grafite, Technip, Samsung, SAWDES, Dublauto, TSA, Idea!

We present below some of the results from researches performed at the centre.

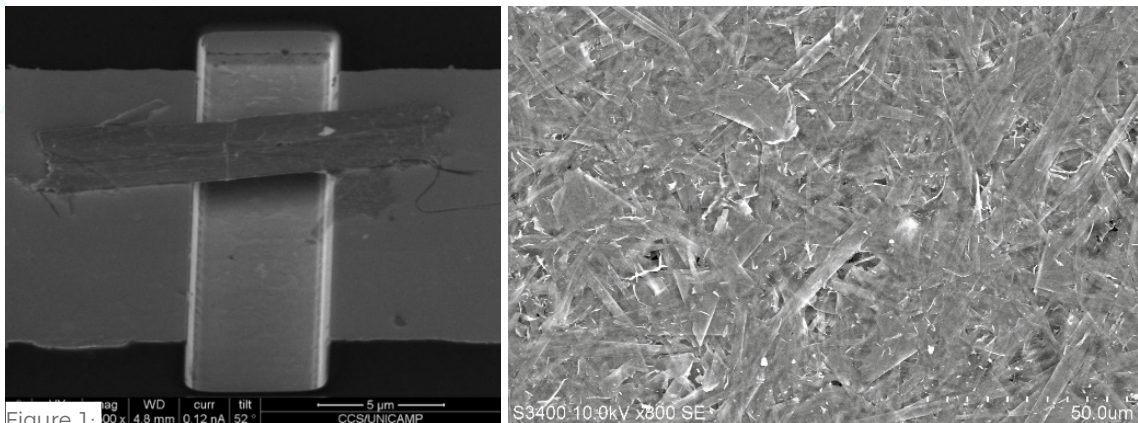


Figure 1: (a) multi-layer graphene nanotape, placed between electrodes through dielectroforesis. (b) nanotape-based conductive thin-film. Work performed in cooperation with Nacional de Grafite.



Figure 2: Highly flexible conductive thin-films, manufactured from graphene nanotapes. Cooperation: Nacional de Grafite

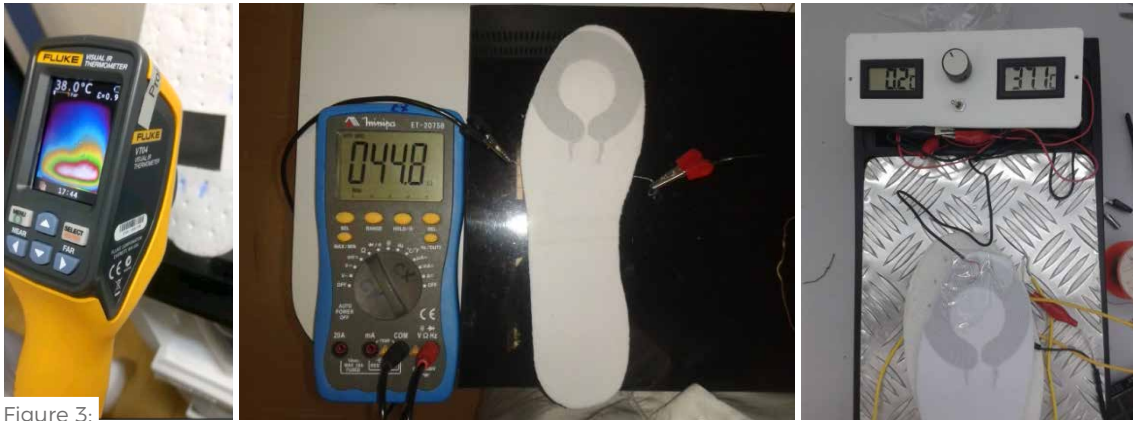


Figure 3: Tests of warmed up insole, nanographite-based (temperature range: 35-45°C) supply voltage - rechargeable batteries; work performed in cooperation with Dublauto



Figure 4: Sandwich-like structure of the insole material, material (function), from top to bottom: fabric (protection)/thermo-fixation film (fixation)/conductive film in nanographite (heating) / thermo-fixation film (fixation) / EVA film (dampening). Cooperation: Dublauto

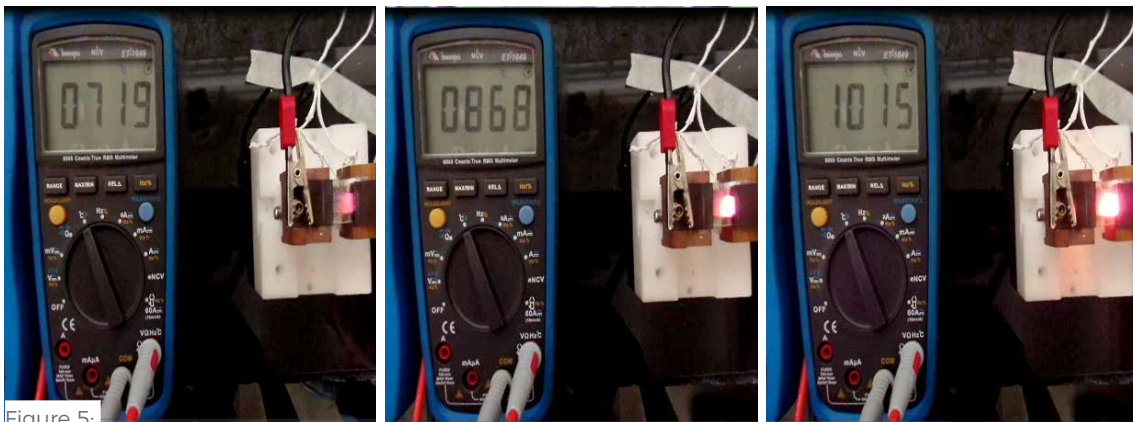


Figure 5: Warming up of nanographite conductive film carrying current (temperatures of up to 700-1000°C), in the air. Graphitic material highly stable under oxygen-rich atmosphere.

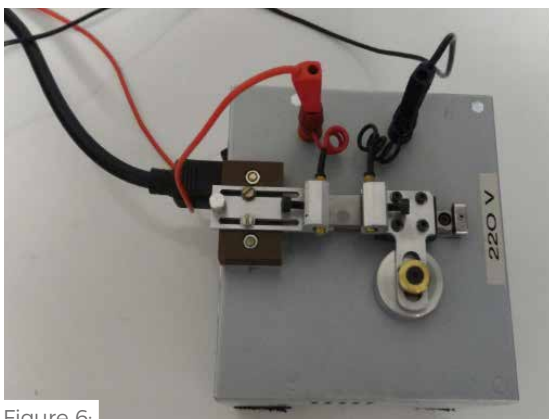


Figure 6: (a) Sensor for mechanical distortion, made of graphene nanotapes deposited on PDMS (Polydimethylsiloxane) substrate, installed in a device for cyclical testing. (b) strain cyclical tests results (up to 5.000 cycles). Monitoring highly stable.

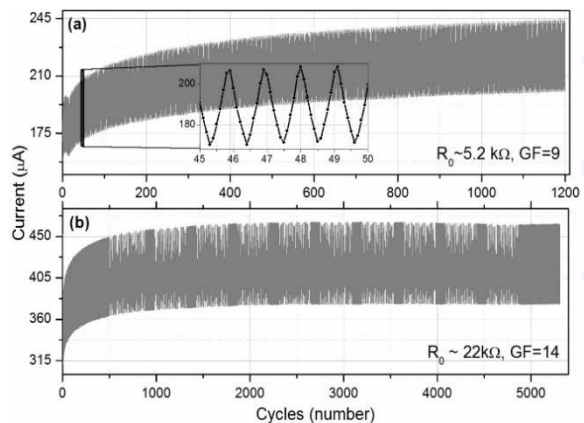




Figure 7: Microfluidic device made of glass and PDMS.

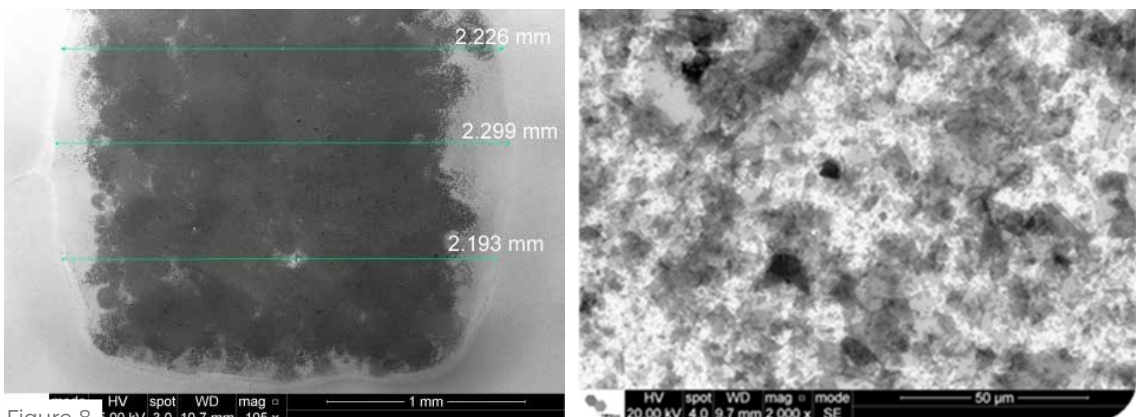


Figure 8: Graphene oxide-based ultra-thin film deposition process by SAW (surface acoustic waves) spraying) - over the surface, and deposition results (high, and low deposition density) - on the bottom. Cooperation: CTI Renato Archer, LNNano.

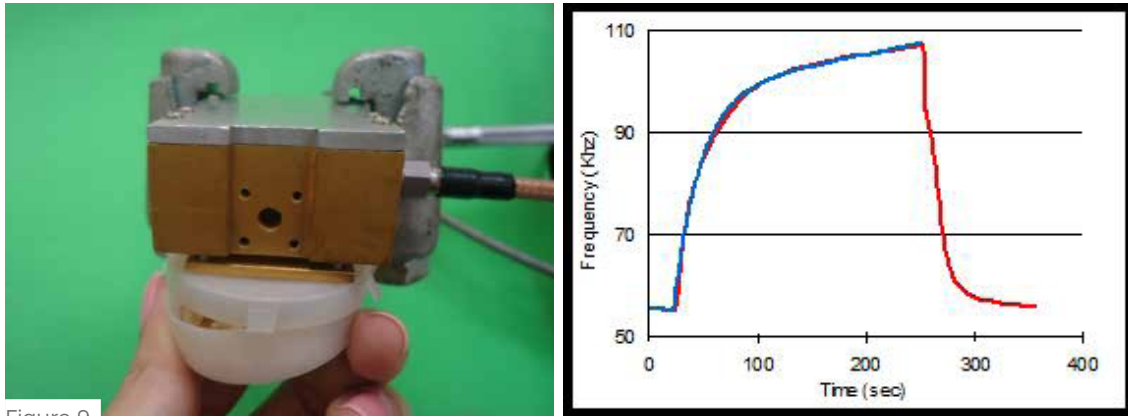


Figure 9: (a) Humidity sensor based on SAW over products (wet activity), and (b) measurement results. Cooperation: CTI Renato Archer.

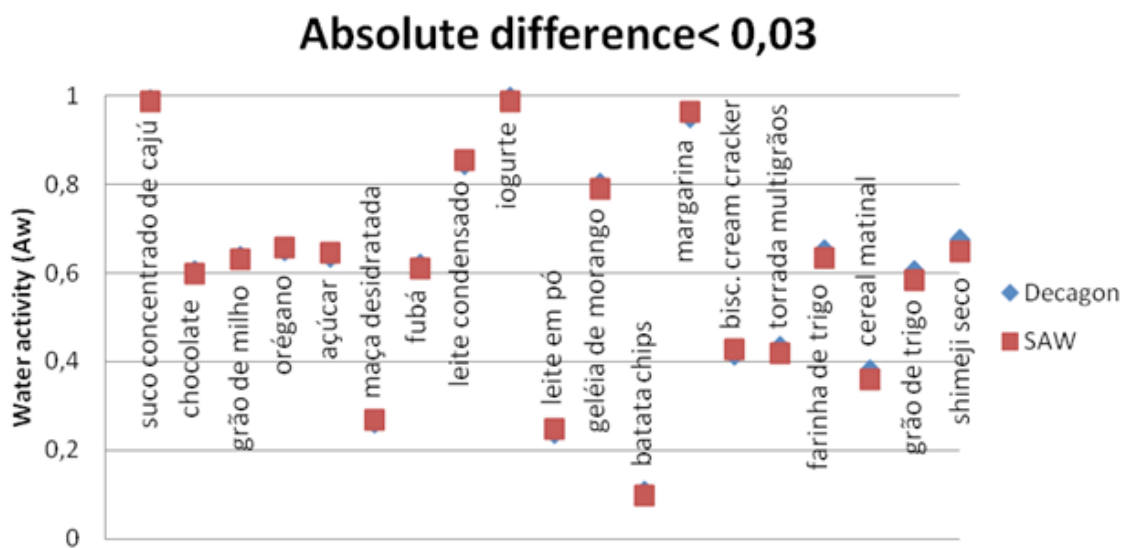


Figure 10: Humidity measurements results (wet activity) for a variety of food products, using SAW, as compared to the commercial sensor (Decagon). Cooperation: CTI Renato Archer.

Contacts:

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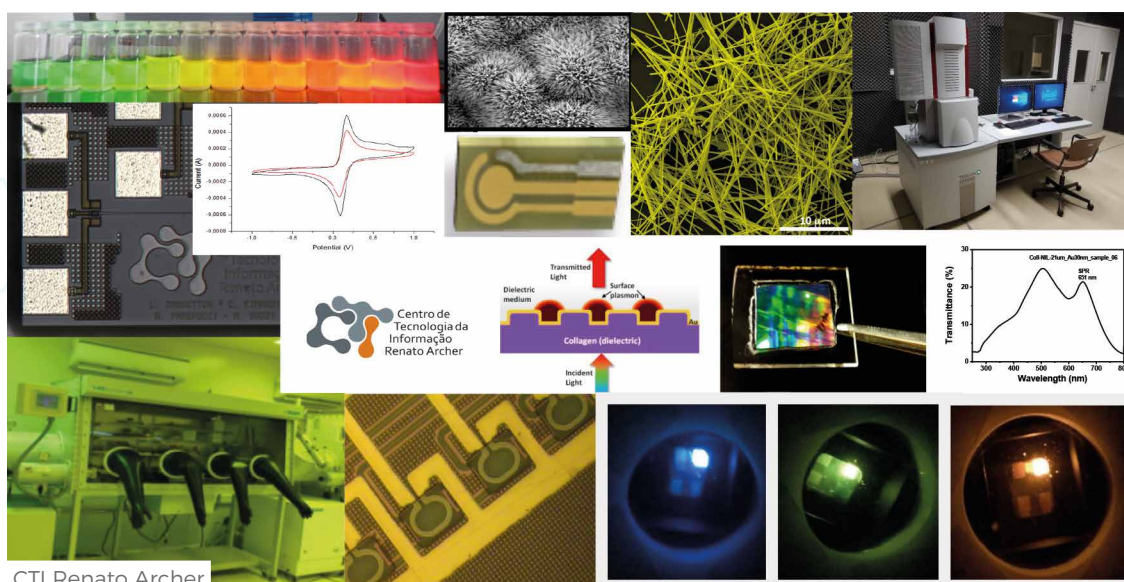
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RENATO ARCHER INFORMATION TECHNOLOGY CENTRE - CTI RENATO ARCHER

The visit was preceded by an institutional video presentation of the CTI Renato Archer. Next, there was a tour across the institutional laboratories. CTI Renato laboratory infrastructure is managed under the coordination of the COLAB - Open Laboratory. One of COLAB's designations is to provide nation-wide laboratory infrastructure for shared usage, based on open labs' framework or for multiusers, accessible to internal and external researchers.



COLAB/CTI coordinates the usage of the equipment, and the facilities, which are maintained as state-of-the-art structures. It counts on a qualified technical staff, keeping up with the historical operation of the CTI Renato Archer in providing support for students, researchers, research centres, universities, Brazilian, and foreign companies.

The Research, Development, and Innovation activities of the CTI, and the Technological Services are a sole responsibility of the respective teams with the Technological Groups using the COLAB. The components' facilities include: The typification, and qualification group of microelectronic components (NAPE), Microsystems Group (NMS), Electronic packaging Group (NEE), Materials and displays Group (NMI), Photonic and hardware systems' design group (NCSH).

At the CTI, the scientific and technological development team probes into the production of such materials up to the phase of a functional hardware prototype, including the eco-friendly disposal of the residues from this activity. The investigations on Materials mainly focus on nanomaterials for sensors and electronic Nano-optical components, based on organic semi-conductors, perovskite (calcium titanium oxide), semi-conductive nanocrystals, and metallic nanoparticles. Micro and Nanofabrication investigations target at integrating the allegedly bottom-up into the top-down production strategies, based on microelectronic techniques, such as direct writing lithography, ink-jet micro-printing and Nano-printing, among others. Devices as the SAW (surface acoustic wave), optical waves, microfluidic and photovoltaic probes, biological sensors, among others are produced and systematically studied for health, communication, and environmental monitoring applications, for instance.

Packaging for advanced applications' components explores state-of-the-art technologies enabling, for instance, that micro-welded sensors' devices operate under low temperatures, inside a vacuum-sealed capsule with special optical windows. Also involved in this process, it is the integration of both passive and active components in the system-in-package, including multi-chip modules. The flip-chip advanced technique is applied to complex telecommunication systems.

New radiation-resistant integrated circuits (ICs) are designed with focus on aerospace applications, in partnership with the INPE (National Institute of Space Research), among others. The ICs are designed with the technology available at the CEITEC S/A, and with more advanced ones from international partners. Foundries are also used to produce semi-conductors for application-specific integrated circuits (ASICs), such as ICs for RF, and more recently for applications of photonics integrated into circuits operating optical signals of up to 30 GHz modulation.

Testing, certification, and failure analysis of devices, boards, and equipment are performed during critical phases of the production process in dedicated systems, aimed at complying with the quality improvement processes of the National Industry, their compliance with international rules, and with P&D&I projects. The SIBRATEC (Brazilian System of Technology) supports such actions.

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NATIONAL NANOTECHNOLOGY LABORATORY (LNNANO) OF THE CNPEM (NATIONAL CENTRE OF RESEARCH ON ENERGY AND MATERIALS)

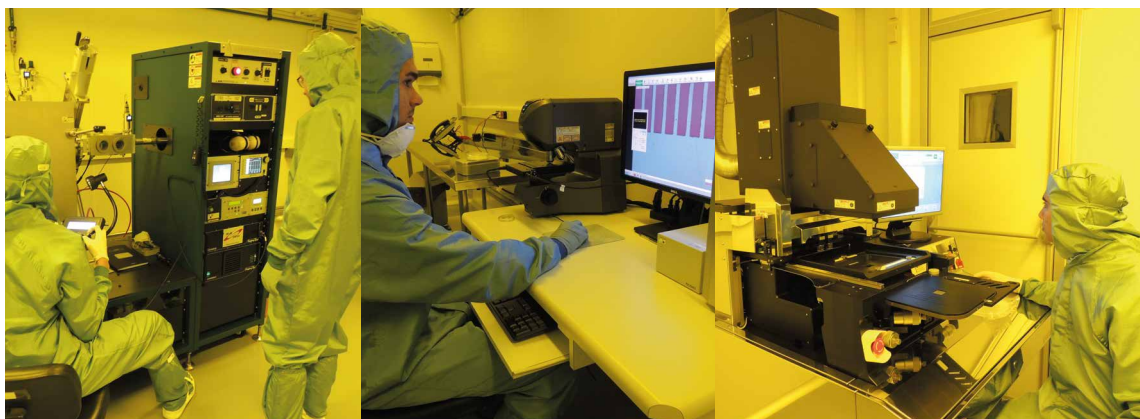
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The visit was preceded by the introduction of the National Nanotechnology Lab team, and then they had a tour to the Lab facilities, such as the Devices Division, and the cleanrooms.

Devices

The Devices Division of the LNNano is dedicated to designing and integrating materials and nanostructured devices for applications in strategic fields such as energy, agriculture, and environment. The scope of the laboratory's activities also includes the support to external users in the research of new nanostructured materials with relevant characteristics to produce electronic, electrochemical, and microfluidic devices.

The division provides users with a cleanroom to produce devices, e.g., sensors and biosensors. Besides microfabrication equipment, the cleanroom is equipped with a set of tools for devices and materials analysis, including laser profilometer, and one atomic force microscope. Since 2017, the devices lab provides users with a set of tools for the electrical typification of the devices.

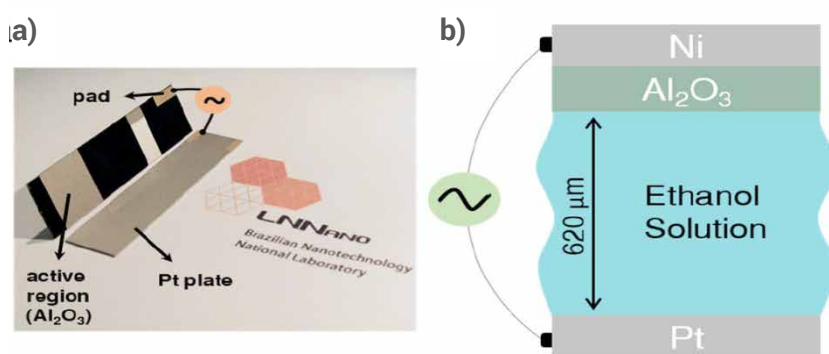


Picture of Cleanroom

Research and development

Capacitive platform for biosensors and sensors

The capacitive platform has been used to design a sensor to monitor the alcohol levels in ethanol fuel. Ethanol is a biofuel broadly used worldwide. Its quality depends on the amount of water in it. The water levels may derive from a poorly performed distillation process or the ethanol adulteration, which is a major concern when it comes to its usage as fuel. Besides consisting in an illegal activity, a high level of water into the ethanol can lead to the malfunctioning of the engine. The proposed sensor is simple, precise, and offers a quick analysis feature. The device is based on standard methods of microfabrication and thin-films deposition. The sensor operates based on capacitance measurements. For that purpose, it uses a capacitor comprising parallel boards with a thin conformational layer of aluminium oxide (Al_2O_3) of 15 nm (Figure 20). The sensor operation ranges from 0% to 100% of water volume in ethanol, and it can detect traces of water starting from 0.5% vol. Such features make it exclusive as compared to other platforms. Ultimately, the good match between the sensor output and the composition analysis performed by gas chromatography strengthens the precision of the methodology proposed for ethanol as a biofuel. The sensor has a technological potential for usage as a point-of-care-type of analysis tool at petrol stations or chemical, pharmaceutical, and beverage industries. The outcomes of this paper have been published at the *Scientific Reports* 7, Article number: 43432 (2017), DOI: 10.1016/j.bios.2016.08.050.



Figures:

(a) Picture of the capacitive sensor, showing the two parallel boards.

(b) Capacitor's set up scheme during ethanol samples assessment. Source - *Scientific Reports* 7, Article number: 43432 (2017).

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OTHER PHOTONICS AND NANOTECHNOLOGY LABORATORIES



REFERENCE CENTERS IN INNOVATIVE TECHNOLOGIES



Development of World Class ELECTROMEDICAL products:

In the health sector, CERTI operates in complete multidisciplinary projects that encompass market analysis, preparation of a business plan, product and process development, trials and testing, manufacturing and the supply chain.

- Medical-equipment: Improvement and development of medical- equipment and devices, encompassing conception, design, mechanics, electronics, hardware and software as well as prototyping and the production process.
- Point of care devices: Development of instrumentation, digital sensors and processing of signals and images in devices for conducting in-vitro diagnosis at the point-of-care such as at medical clinics, healthcare centers or locations served by community healthcare agents.
- Information and Communication solutions: Systems and applications for monitoring, control and management of medical and hospital equipment and environments. cations served by community healthcare agents.
- Diagnostic imaging devices: Mechanical and electronic development for medical imaging; embedded digital microscopy; software and algorithms for digital processing of radiographic images and ultrasonography, allowing the identification of anatomic structures and anomaly segmentation analyzing format, density texture of the tissues.



Point of Care Equipment



Labelectron

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NATIONAL INSTITUTE OF SCIENCE AND TECHNOLOGY OF PHOTONICS – INFO

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The National Institute of Photonics – INFO, in its second phase, was approved with a new scientific program, in which it maintains photonics as the main area, and will address problems and challenges in the following subjects:

- (a) Nonlinear Photonics, Devices and Applications;
- (b) Biophotonics and
- (c) Optomicrofluidics.

In these three themes, we highlight the following global and strategic problems for the country that will be researched using photonics with applications in the areas of nanotechnology and health:

- (a) manufacturing, characterization and applications of nanostructured photonic materials;
- (b) studies of transverse nonlinear effects;
- (c) new types of lasers (random lasers);
- (d) generation and application of extreme ultraviolet radiation using high harmonics;
- (e) innovations in photovoltaic cells;
- (f) new organic materials for LEDs;
- (g) development and application of imaging techniques (Optical Coherence Tomography (OCT), photoacoustic, polarized light) for diagnosis in the oral cavity (soft tissues and hard tissues);
- (h) nanobiosensor development and applications;
- (i) studies in photodynamic therapy with nanostructured materials;
- (j) new applications of optical tweezers,
- (k) development of spectral imaging tumor diagnostic methods and a set of activities in the optomicrofluidic area, from the determination of ablation thresholds of materials of interest, production and integration of optical components and devices microfluidics up to microvascular flow simulation.

The INFO research program on these topics will continue to contribute to the advancement of scientific development and training of highly qualified HR, whose results are and intend to continue to be recognized in the international community.

This program is in line with the global advance of research in the proposed areas, and will certainly provide, unequivocally, a greater insertion of the INFO in the international scenario, opening doors for students trained through the Institute to interact with researchers in other major centers of research in the world, besides being prepared to assume positions in Brazilian institutions.

The training of these students will certainly bring important return to the country in strategic areas and future bearers for its development.

The INFO group consists of three subgroups: a subgroup of consolidated institutions with 26 researchers, a subgroup of emerging institutions with 15 researchers and a subgroup of institutions with associated groups with 22 researchers.

The INFO management committee is composed of permanent researchers from institutions with important contributions to scientific research and training of students in the country, being coordinated by a senior researcher of the Department of Physics of the Federal University of Pernambuco, researcher IA of CNPq with extensive scientific experience (H-28 index), and with experience in project management (it was responsible for raising approximately US\$ 5 million in individual projects in the last 14 years, including projects with the private initiative (Ericsson do Brasil), academic-scientific management (he was Coordinator of the Physics and Astronomy area of CAPES) and public management (he was Secretary of State for Science and Technology and also State Secretary of Education of Pernambuco).

In this new stage, INFO intends to expand its scientific and technological indicators, continue the emphasis on the training of highly qualified human resources in the use of photonics and its applications, generate new scientific and technological results in the proposed areas for action (together with indicated companies), to stimulate innovation among its participants by exploiting technological results in an entrepreneurial way and to contribute strongly in the area of scientific education and diffusion, to increase the scientific literacy of society and the initial and continuing training of physics students for academic careers or teaching certificate.

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Links

1. In vivo assessment of periodontal structures and measurement of gingival sulcus with Optical Coherence Tomography: a pilot study, see <http://www.octnews.org/articles/7230934/feature-of-the-week-08-17-2017-in-vivo-assessment/>
2. <http://www.sbfisica.org.br/v1/home/index.php/pt/destaque-em-fisica/352-quebra-de-simetria-de-replicas-em-lasers-convencionais>
3. <http://www.sbfisica.org.br/v1/home/index.php/pt/destaque-em-fisica/290-investigando-turbulencia-em-lasers-aleatorios>

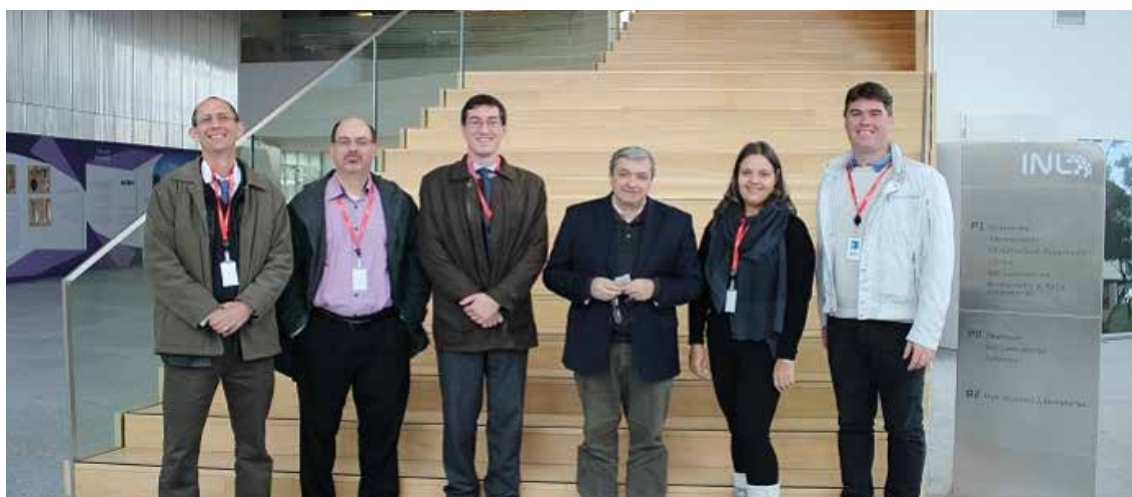
BRAZILIAN TECHNICAL MISSION IN THE EUROPEAN UNION

The Ministry of Science, Technology, Innovations, and Communications submitted the project “Innovation on Photonics & Nanotechnology for Medical Devices” to the 9th Call for the European Union-Brazil Sector Dialogues Support Facility, for Sector Dialogues, and Information Society purposes. Among its actions, the project includes sending a Technical Mission to visit reference institutions in Photonics, and to promote the integration between Brazilian and European experts in Photonics and Nanotechnology innovation.

Said technical mission was performed between March 5 and 9, 2018. Among the activities they engaged in, stood out: a technical visit to the INL (International-Iberian Lab of Nanotechnology), in Braga/Portugal, and to the IMEC (*Interuniversity MicroElectronics Center*), in Leuven/Belgium. The mission had a meeting with the General Management for Communication Networks, Content, and Technologies (DG CONNECT), and with the General Management of Research and Innovation (DG RTD) in Brussels/Belgium. Still within the scope of the activities related to the *Photonics21* technological platform, the Brazilian delegation attended the event “*Winning the future - Europe’s age of light*”.

Visit to INL (International-Iberian Lab of Nanotechnology)

On March 5, 2018, the Brazilian delegation paid a technical visit to the INL (International-Iberian Lab of Nanotechnology), in Braga/Portugal. They were welcome by Professor Paulo Freitas, General Director for the Institute.



Visit to the INL on 03/05/2018. Manuel Steidle, with CERTI Foundation; Roberto Panepucci, with CTI Renato Archer; Leandro Antunes Berti, with the CGTC/MCTIC; Paulo Freitas, with the INL; Sandra Pacheco Renz, with the CGTC/MCTIC, and Fabricio Marchini, with Fiocruz Paraná;



INL (International-Iberian Lab of Nanotechnology)

The INL is an intergovernmental organization, jointly founded by Spain, and Portugal governments. It is in Braga, Portugal, within a 26.000 m² area. Their main areas of operation are:

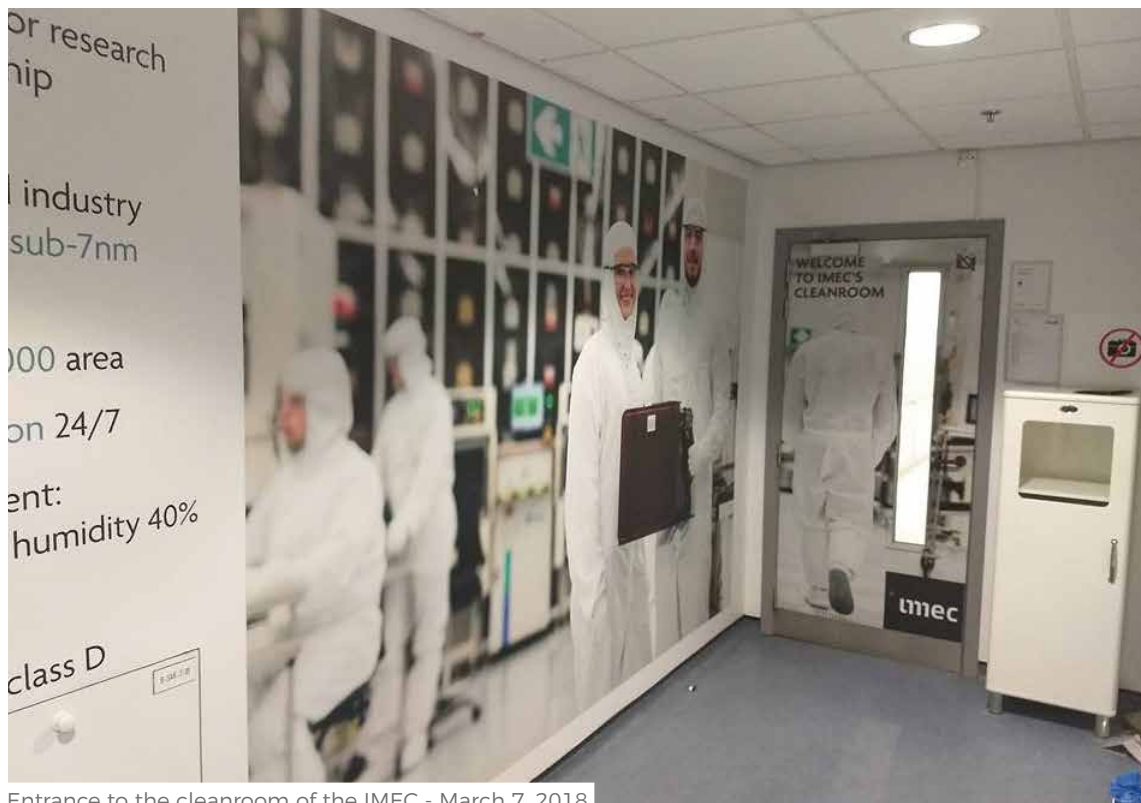
- Nanophotonics;
- Nano-production;
- Nanoelectronics;
- Quantum materials;
- Life Sciences.

Meeting at the DG Connect

On March 6, 2018, the Brazilian delegation participated in a meeting with the General Management of Communication Networks, Content and Technologies (DG CONNECT), in Brussels/Belgium regarding nanoelectronics and Nano systems. DG CONNECT is responsible for the European Union's policies regarding the digital market, internet security, and digital innovations. They set forth strategies for the activities in Research and Innovation related to Information and Communication Technologies (ICT) within the Horizon2020 program.



DG CONNECT meeting on March 6, 2018. Manuel Steidle, with the CERTI Foundation; Sandra Pacheco Renz, with the CGTC/MCTIC; Leandro Antunes Berti, with the CGTC/MCTIC; Roberto Panepucci, with the CTI Renato Archer; Francisco J. Ibáñez, Head of the Department of Industry Competitiveness; Andreas Lymberis, Head of the Department of Wearables and Bioelectronics; Marco Aurélio Krieger, Vice-President of Health Production and Innovation - VPPIS/Fiocruz; Fabricio Marchini, with the Fiocruz Paraná; Henri Rajbenbach, Components Senior Expert.



Entrance to the cleanroom of the IMEC - March 7, 2018

IMEC

On March 7, the Brazilian delegation paid a technical visit to the IMEC (*Interuniversity MicroElectronics Center*), in Leuven/Belgium. They were welcome by Dr. Paul Malisse - Business Manager for the IMEC IC-link.

IMEC develops many different things, from new materials, new micro and Nanofabrication technologies, new photonics and nanoelectronic devices, the platforms to produce such devices, and even final solutions, including the associated software.

They visited the cleanroom, escorted by Dr. Patrick Verdonck, Senior Researcher.

Meeting at the DG RTD

On March 8, 2018, the Brazilian delegation participated in a meeting with the General Management of Research and Innovation (DG RTD), in Brussels/Belgium regarding the potential for future cooperation with Brazil across a variety of nanotechnology areas. DG RTD is responsible for the European Union's policies regarding Science and Innovations.



Meeting between the DG-RTD and the Brazilian Delegation in Brussels, on March 8, 2018. First row: from left to right: Georgios Katalagarianakis; Olga Rio, Valeria Lautizi, Jana Drbohlavova, Roberto Panepucci, and Heico Frima; Second row: Leandro Antunes Berti, with the CGTC/MCTIC; George Kotsikas, Fabricio Marchini, with the Fiocruz Paraná, and Fergal Donnelly, Manuel Steidle, with the Fundação CERTI.

Participation in the event 'Winning the future - Europe's age of light of the Photonics21'

In the scope of the Photonics21 program, between March 8 and 9, 2018, the Brazilian representatives attended the event '*Winning the future - Europe's age of light*'.

Photonics21 is a European technological platform that represents the Photonics community and, along with the European Committee, develops and implements the Photonics strategy within the scope of the Horizon 2020 Program.

On the first day of the event there were presentations, and the second day was dedicated to technical workshops across various areas in Photonics, as follows:

- Industrial Production and Quality;
- Life Sciences and health;
- Lighting, Electronics, and Emerging displays;
- Safety, metrology and sensors;
- Design and Production of Components and Systems;
- Photonics Research, Education, and Training;
- Automotive and Transportation;
- Agriculture and Nutrition.

The workshops showed state-of-the-art projects in Photonics.



Photonics 21, 03/08/2018. Fabricio Marchini, with the Fiocruz Paraná; Roberto Panepucci, with the CTI Renato Archer, Leandro Antunes Berti, with the CGTC/MCTIC, Sandra Pacheco Renz, with the CGTC/MCTIC, Manuel Steidle, with the Fundação CERTI.



"Winning the future - Europe's age of light "Photonics21 Museum of Fine Arts/ Musées Royaux des Beaux Arts

PHOTONICS AND NANOTECHNOLOGY INNOVATIONS FOR MEDICAL DEVICES



European Union



MINISTRY OF
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AFFAIRS

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INNOVATION AND COMMUNICATIONS

