

MAIN PUBLICATIONS

Photonic Materials

Oliveira SL et al. 2007. Perylene Derivatives with large two-photon absorption cross-section for application in optical limiting and upconversion lasing. *Adv. Mater.* **17**:1890.

Correa CS et al. 2007. Three and four photon excitation of MEH-PPV. *Adv. Mater.* **19**:2653.

Guedes I, Misoguti L, Zilio SC. 2006. Precise control superluminal and slow light propagation by transverse phase modulation. *Opt. Express.* **14**:6201.

De Boni et al. 2004. Z-scan measurements using femtosecond continuum generation. *Opt. Express.* **12**:3921.

Oliveira S et al. 2006. Two-photon absorption cross-section spectrum of conjugated polymer obtained using the white-light continuum Z-scan technique. *Applied. Phys. Lett.* **88**:021911.

Zanatta AR et al. 2006. Thermally synthesized ruby microstructures and luminescence center. *Appl. Phys. Lett.* **100**:113112.

Monteiro C et al. 2002. Red and green light emission from samarium-doped Amorphous aluminum nitride films. *Adv. Mater.* **14**:1154.

Biophotonics

Milori D et al. 2006. Organic matter study of whole soil samples using laser-induced fluorescence spectroscopy. *Soil. Sci. Soc. Am. J.* **70**:57.

Rodrigues UF et al. 2008. Changes in optical properties caused by UV-irradiation of aquatic humic substances from Amazon River Basin: seasonal variability evaluation. *Environ. Sci. Tech.* **42**:1948.

Souza CS et al. 2007. Optimized photodynamic therapy with systemic photosensitizer following debulking technique. *Dermatology Surgery.* **33**:194-198.

Souza CS et al. 2005. Topical photodynamic therapy for Bowen's disease of the digit in epidermolysis bullosa. *British Journal of Dermatology.* **153**:664-699.

Kurachi C et al. 2001. Curing of dental composites by blue light emitting diodes. *Dental Materials.* **17**:309.

Atomic physics

Mancini MW et al. 2004. A continuous source of heteronuclear cold molecules. *Phys. Rev. Lett.* **92**:133203-1.

Courteille P, Bagnato VS, Yukalov V. 2001. Bose-einstein condensation of trapped atomic gases. *Las. Phys.* **11**:659-800.

Teles F et al. 2002. Characterization of the Brazilian atomic clock: accuracy and major shifts. *Metrologia.* **39**:135-141.

Marcassa LG et al. 2005. Atomotron: A storage ring to investigate cold unidimensional atomic collisions. *Phys. Rev.*

A. Rapid Comm. **72**:R060701.

Henn EAL et al. 2007. Global thermodynamics variables description for a confined cold gas undergoing Bose-Einstein condensation. *Nuclear Physics A.* **790**:800-803.

Brickman KA et al. 2007. Magneto optical trapping of cadmium. *Phys. Rev. A.* **76**:043411.

RESEARCH, INNOVATION
AND DISSEMINATION CENTERS (RIDC)

MAIN RESEARCHERS

Director

Vanderlei Salvador Bagnato

Cleber Renato Mendonça

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Partner Institutions

State University of Campinas (Unicamp)

- Gleb Wataghin Physics Institute

- Electrical and Computing Engineering School

- Chemistry Institute

- School of Medical Sciences

University of São Paulo (USP)

- São Carlos Physics Institute

- São Carlos School of Engineering

- Ribeirão Preto School of Medicine

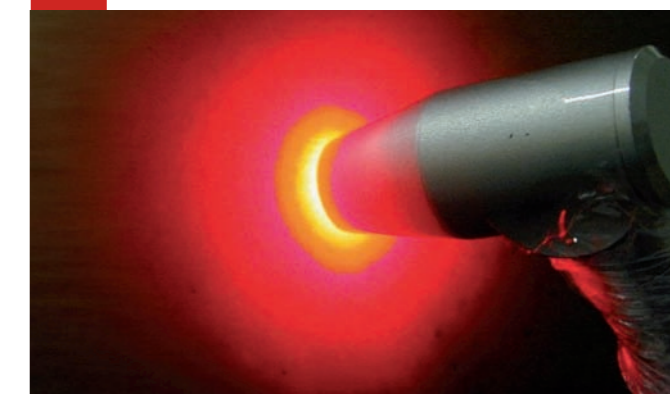
Institute of Energy and Nuclear Research (Ipen)

- Laser and Applications Center

Other Institutions

EMBRAPA Instrumentation Center

Amaral Carvalho Hospital



Laser and led therapy in bio-modulation

Under the general rubric of Basic Research, the RIDC currently animates three major themes. In addition the Center supports eleven research partnerships with various dental, medical and veterinary schools pursuing research and treatment in medical dentistry, oncology and crop diseases.

Specific research programs in *Molecular and Optical (AMO) physics* concentrate on quantum condensed matter, cold atomic and molecular collisions as well as quantum atomic fluids like Bose-Einstein condensate, and the development of state-of-the-art time and frequency standards by using atomic clocks.

The *Photonic materials* program develops polymers and other organics, applies ultrashort light pulses for manufacturing and analysis, and characterizes optoelectronic thin films. *Biophotonics* investigates new noninvasive optics-based diagnostic tools, cancer therapies involving light (photodynamic therapy), early photodiagnosis of plant and crop diseases, and environmental issues such as pesticide degradation and pollution of ground waters.

These research programs are imbedded in partnering agreements with professional schools in the São Carlos region. Because of its unique expertise in optics, materials, and device development, the Center is planning a new basic research thrust into the multidisciplinary area of *plasmonics and nanophotonics*.

The Innovation axis develops new devices, interfaces with local high-technology enterprises, and creates spin-off companies to commercialize new applications developed at the Center. This activity is concentrated at the new LAT laboratory-Laboratory for Applied Technology and has resulted in the creation of thirty optics-based companies in São Carlos, three new spin-off companies alone in 2006.

The Outreach program involves educational activities at all levels from elementary school to post-graduate continuing education. The Week of Optics, SEMOPTICA, has become a major annual event in the school calendar all over the State of São Paulo. The Center broadcasts on Educational Television not only university level courses, but also programs popularizing important developments in optics-based science and technology. The Center has developed a Mobile Science Unit, a specially prepared bus to visit schools for the purpose of presenting scientific demonstration and exhibitions.

Optics and Photonics Research Center (CEPOF)

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MAIN RESEARCH TOPICS

Atomic physics

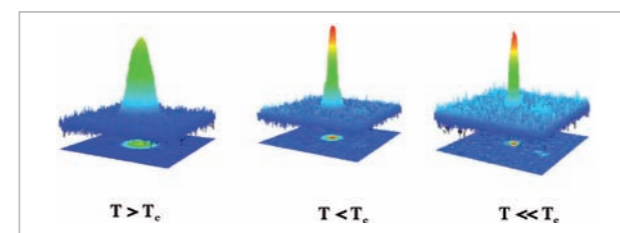
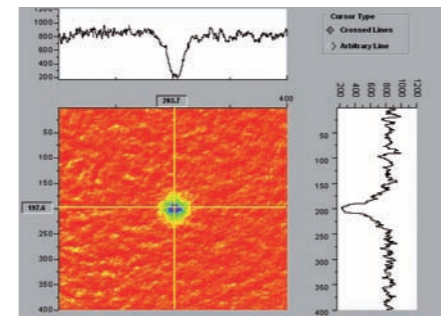
Bose-Einstein condensate of Rb and coherent modes
Cold atomic collisions
Time and frequency metrology

Photonic materials

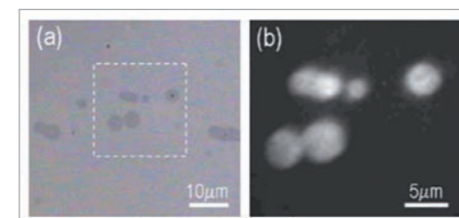
Nonlinear spectroscopy in organic materials
Coherent control of light
Crystallization of a-Si
Optoelectronics of doped a-Si
Photo-structural changes in chalcogenides

Collaborative network

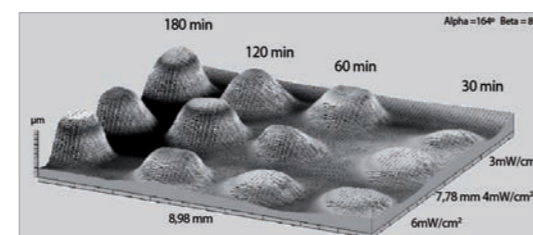
Clinical implementation of photodynamic therapy
In vivo studies to optimize PDT
Development of a real time dosimetry for photodynamic therapy
Microbial control using photodynamic reactions
Investigation of photobleaching in dental whitening
Optics applied to agriculture and environment
Ex vivo - determination of time of death by fluorescence spectroscopy
Fluorescence imaging and optical diagnostic tools
Optical fluorescence for diagnosing cancer and other lesions
Photoprocessing of dental materials
Laser ablation of hard dental tissues and materials – selective removal
Laser and LED therapy in bio-modulation
Development of a cylindrical symmetry wavefront sensor
Optical methods for evaluating organ conditions and transplant procedures



Time of flight image showing the Rb condensate with more than 100,000 atoms



Optical microscope image (a) and Raman imaging (b) of silicon micro-crystals that develop on the surface of amorphous Si films doped with approx. 0.1 at.% of Ni



Time and power density of irradiation on a GGS film sample

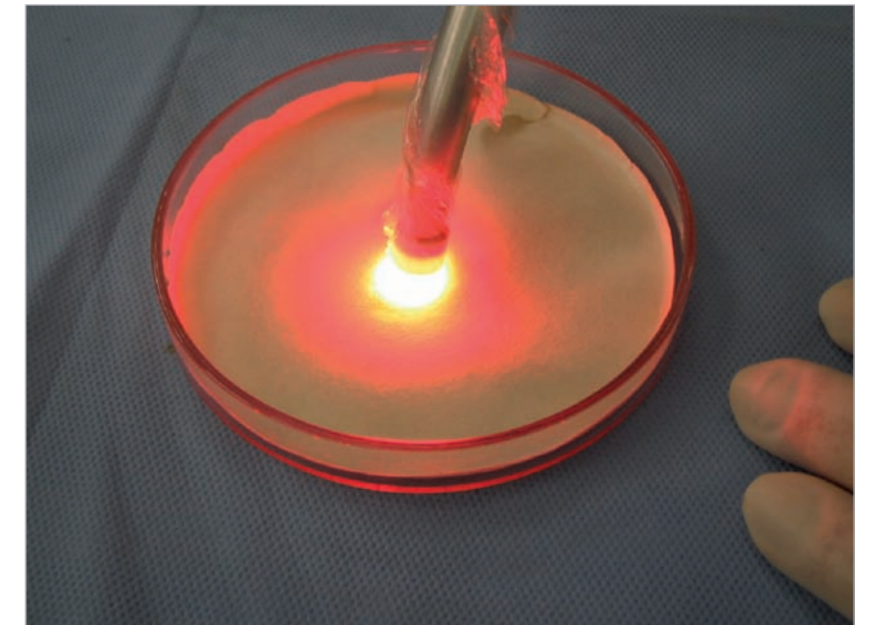
SUMMARY OF RESULTS TO DATE AND PERSPECTIVES

The photodynamic therapy and optimization projects of this procedure have obtained as a result an optimized dosimetry process that allows for the real time evaluation of the process. As a consequence of this, we have been successful in attaining a higher rate of success than usual in eliminating tumors. The development of new instruments based on LED and lasers have enabled us to perform superficial and interstitial procedures more efficiently.

The project Optical Fluorescence Diagnosis of Cancer and Other Lesions has developed both techniques and equipment that permit biopsy results with sensitivity higher than 94%. Still as far as determining UV-caused skin lesions is concerned, we are able to identify the onset of threatening lesions capable of evolving to tumors.

An optical fluorescence evaluation technique, such as the one we have developed, is used for assaying the viability of organs to be transplanted. Also finished are the methodology and clinical prototype, both of which have been successfully employed for clinical purposes for the first time. The project for optical detection of pathologic tissue conditions has achieved a precision level higher than 90% in determining time of death.

We have also developed a new technology that conjugates both ultrasound and light for improving the cure efficiency of composite dental resins in more than 20%. Our work has also borne fruit in dental photobleaching, resulting in marketable systems, as well as the development of a new gel based on coal nanoparticles, which yields higher photobleaching efficiency. By using photodynamic therapy techniques, we have developed prototypes that are now being clinically employed in periodontics for mouth and dental prostheses disinfection. We have been able to attain up to nine logarithmic orders in bacterial and fungal reduction. The systems developed are being used in immunosuppressed, transplanted and elderly patients, who do not tolerate the aggressivity of most fungicidal agents.



Microbial control using photodynamic reaction