Nanotechnology and Nanoscience in Brazil

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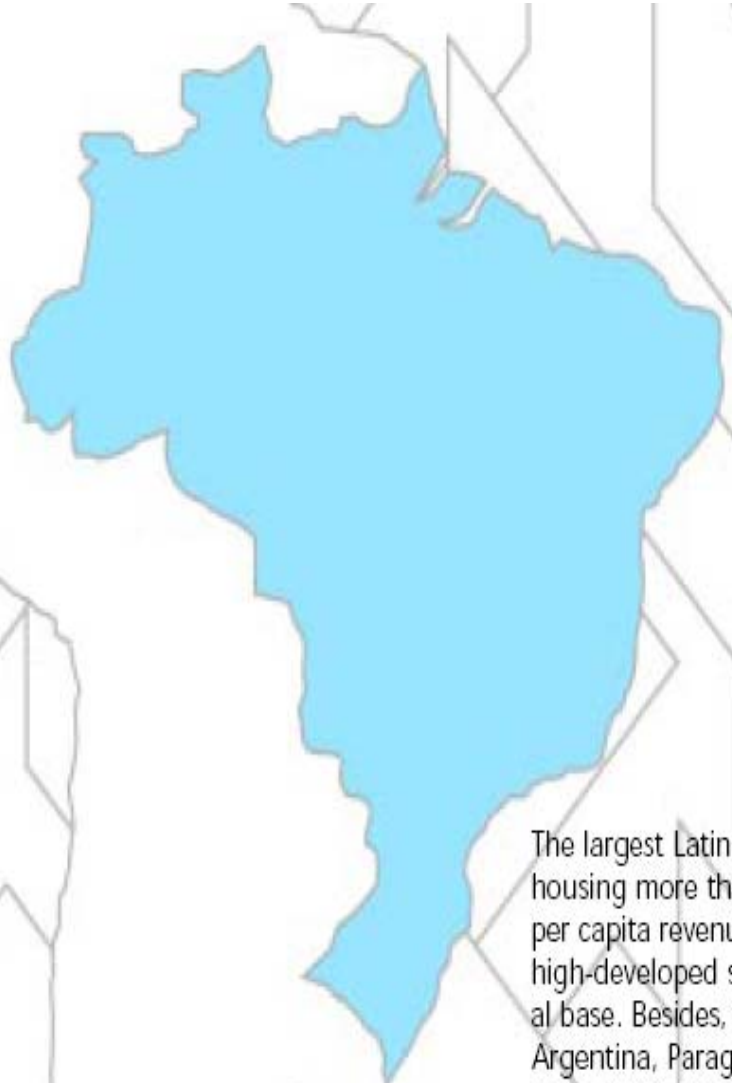
Outline

- A View of the Brazilian System for Technology and Science
- Strategic Plan for Nanotechnology
- Landmarks and Numbers
- Initiatives and Ongoing Projects
- Trends and Next Steps : the Near Future



The largest Latin-American country, Brazil has an area of 8,5 millions of square kilometers housing more than 175 million people. In 2003, Brazil's GNP was US$ 493 billions, with a per capita revenue of US$ 2,789.00. Within the Brazilian economy, it is worth mentioning high-developed sectors such as agriculture and cattle breeding and a very complex industrial base. Besides, the country is the leader of Mercosul, an economic block joining Brazil, Argentina, Paraguay and Uruguay. Established in 1991, this block emerged as a free trade zone, but its major objective is to become a common market.

Technological innovation – as an instrument for the social and economic development – is one of the priorities of the Government of President Luiz Inácio Lula da Silva. This was emphasized through the Industrial, Technological and Foreign Trade Policy announced and launched in March 2004, in which FINEP has a crucial role.

Brazilian System for Technology and Science

- System supported and ruled by Federal and State Governments in connection with Private Sectors (e.g: oil industry).

- Federal System involves the Ministries of Science and Technology (MCT), of Defense (MD), of Mining and Energy (MME) , of Development, Industry and Foreign Trade (MDIC) and of Education (MEC).

- Major initiatives are established in the Federal Government's Pluri-annual Plan (PPA), which guides the design of the Federal Budget and actions through programs to be coordinated by funding agencies.

Brazilian System for Technology and Science: Supporting and Funding

Funding Agencies :

- CNPq - MCT (National Council for Scientific and Technological Development): basic and applied research
- Finep – MCT (Research and Projects Financing): technological development in strong connection with Industry sectors.
- CAPES – MEC : graduate education.
- FAPESP , FAPERJ, FAPEMIG (State Agencies).

Brazilian System for Technology and Science: Supporting and Funding

Main Instruments :

Sectorial Funds : created in 1999 are project financing instruments for domestic research, development and innovation. They have roots in the privatization that took place along the 90's. These funds originate from contributions according to companie's invoicing and/or from earnings arising from the exploitation of natural resources belonging to the Federal Government. Nanotechnology is funded by different sectorial funds (eg.: energy, oil , …)

Brazilian System for Technology and Science: Supporting Nanotechnology- Landmarks

- 1987 – CNPq investments on growing of semi-conductors.
- 2001 – CNPq supports 4 networks and 4 “Institutos do Milenio”.
- 2003 - “Taskforce” for elaborating a National Program.
- 2003 – Coordination for Policy and Programs on Nanotechnology.

Brazilian System for Technology and Science: Supporting Nanotechnology- Landmarks

- 2004 - Starts the Program for Developing Nanoscience and Nanotechnology within PPA – 2007.
- 2004 – Forum to discuss the National Laboratory on of Micro and Nanotechnology.
- 2004 – Starts the support from Sectorial Funds (transverse actions).
- 2005 – Launched the National Program on Nanotechnology (PNN).

Brazilian System for Technology and Science: Supporting Nanotechnology- Landmarks

- 2005 – Memorandum of Understanding : Brazil-Argentina Center of Nanotechnology (CBAN).
- 2006 – Workshop on Nanoparticles : first initiative within CBAN.
- 2006 – Petrobras Thematic Network.

Brazilian System for Technology and Science: Supporting Nanotechnology- Landmarks and Numbers

2001 – Inducing Cooperative Research

Networking Creation	(R$1,00 – U$ 3.00)		Period
NANOBIOTEC			October - 2003
NANOMAT			
NANOSEMIMAT			
RENAMI			
TOTAL	R$ 3.000.000,00		

Supporting Nanotechnology- Landmarks and Numbers

2003 – Consolidation of Cooperative Research and Starting Sectorial Funds Financing

	(R$1,00 ~ U$ 3.00)		Period
CT-Petro/CNPq 01/2003	R$ 2.122.484,00	17 Projects	November - 2005
CT-Energ/CNPq 01/2003	R$ 3.029.613,00	15 Projects	November - 2005
CT-FVA/CNPq 01/2003 (1ª Fase)	R$ 1.500.000,00	33 Networks	February - 2004
TOTAL	R$ 6.652.097,00		

Networks			Period
NANOBIOTEC	R$ 1.250.000,00		Outubro/2004
NANOMAT	R$ 1.350.000,00		
NANOSEMIMAT	R$ 1.150.000,00		
RENAMI	R$ 1.250.000,00		
TOTAL	R$ 5.000.000,00		

Supporting Nanotechnology- Landmarks and Numbers

2004 – Launching the National Program " Desenvolvimento da Nanociência e da Nanotecnologia" (Developing Nanoscience and Nanotechnology) – PPA -2004-2007

	(R$1,00 – U$ 2.70)		Final Period
Calls for Projects			
MCT/CNPQ 012/2004	R$ 3.500.000,00	Cooperative Research (13 Projects)	October - 2006
MCT/CNPQ 013/2004	R$ 100.000,00	Evaluation Impact (5 Projects)	October - 2006
MCT/FINEP/FNDCT – Nanotechnology – 01/2004	R$ 930.000,00	Cooperative Research (6 Projects)	November - 2006
Networks			
REDE NANOBIOTEC	R$ 500.000,00	(R$ 1.800.000,00)	October - 2005
REDE NANOMAT	R$ 500.000,00		
REDE NANOSEMIMAT	R$ 400.000,00		
REDE RENAMI	R$ 400.000,00		
LNLS	R$ 2.000.000,00	Supporting Laboratories and Networking	-
Other			
Events	R$ 70.000,00	Supporting Scientific Events	-
TOTAL	R$ 8.400.000,00		

Supporting Nanotechnology- Landmarks and Numbers

2005 - Launching the National Program of Nanotechnology

	R$ 1.00 ~ U$ 2.50		Period
Calls			
I MCT/CNPq n° 28/2005	R$ 3.000.000,00	Young Researches (19 Projects)	Outubro/2007
I MCT/CNPq n° 29/2005	R$ 12.000.000,00	Networking (10 Groups)	Outubro/2009
MCT/FINEP/Nanotecnologia n° 03/2005	R$ 10.500.000,00 (demand: R$4.200.000,00	Cooperative Research (9 Projects)	Julho/2007
I MCT/CNPq n° 31/2005	R$ 300.000,00	International Cooperation - France (5 Projects)	Outubro/2007
MCT/CNPq n° 58/2005	R$ 1.000.000,00	Incubating (11 Projects)	Outubro/2006 (First Call) Junho/2007 (Second Call)
Laboratories			
LNLS	R$ 12.000.000,00		-
INMETRO	R$ 14.000.000,00		-
LABORATÓRIOS NACIONAIS			
LNNA - EMBRAPA	R$ 1.000.000,00		
CBPF	R$ 4.757.406,88		
CETENE	R$ 0		
TOTAL	R$ 58.557406,88		

Brazilian System for Technology and Science: Latest News (Nanotech)

- President Lula launches at LNLS (Sincroton National Lab.) the new "Brazilian Program for Nanotechnology" involving different sectors and aligned with Brazilian development goals (August – 2005).

- Announced the creation a reference laboratory on Nanotechnology in the North-East of Brazil. Initial investments: R$ 4.000.000,00 (~U$ 1.800.000,00). (July – 2006).

- Petrobras supports Nanotechnology through a Thematic Network (November 2006).

Brazilian Program for Nanotechnology and Nanoscience 2004 - 2007

Four principal axes of action:

- Creating new Laboratories and Networking
- Supporting Laboratories
- Funding Projects
- Special Program on Education

Brazilian Program for Nanotechnology and Nanoscience 2004 – 2007: Specific Goals

Specific Goals	Reference Values (2003)	2004	2005	2006	2007
1. Human Resources Education	600	690	790	950	1140
2. Patents	17	22	28	35	43
3. Exporting Goods	1	4	8	13	21
4. Rate of Growing on Technological Products	1200	20%	44%	73%	107%
5. Rate of Growing on Companies on Nanotechnology	10	50%	100%	150%	200%

On Going Projects and Recent Achievements ….

Summary of Cooperative Research (until 2005)

Network	People	Institutions	Companies	Articles	Patents
Nanobiotecnologia	92	19	9	674	25
Nanosesimat	55	18	1	970	15
Nanoestruturados	150	23	--	225	--
RENAMI	61	17	3	450	57
Totals	258	77	13	991	97

Solid Lubrification

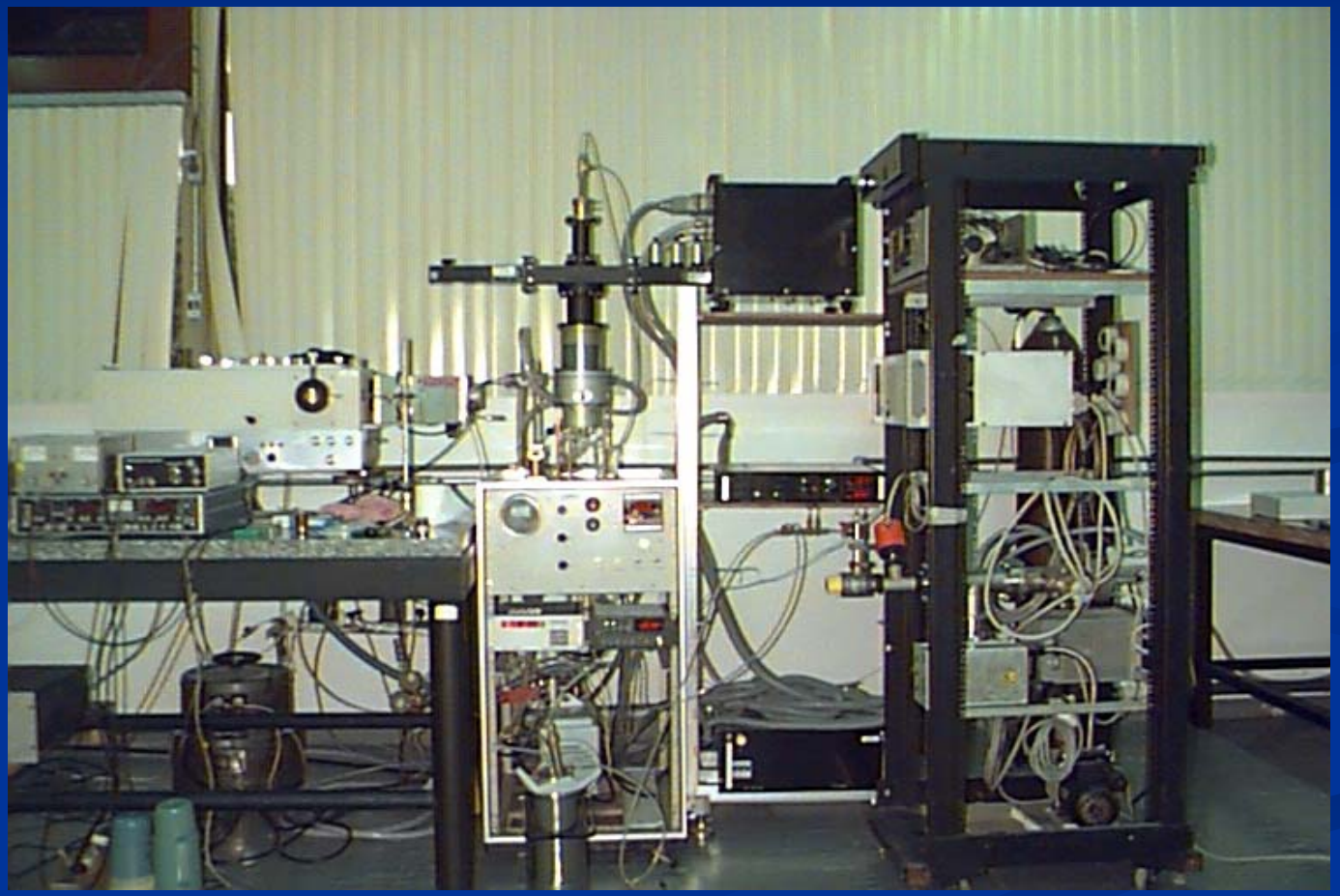
P.Is: **Vladimir Jesus Trava Airoldi**
Lucia Vieira Santos

National Institute for Space Research– INPE

Evaldo José Corat

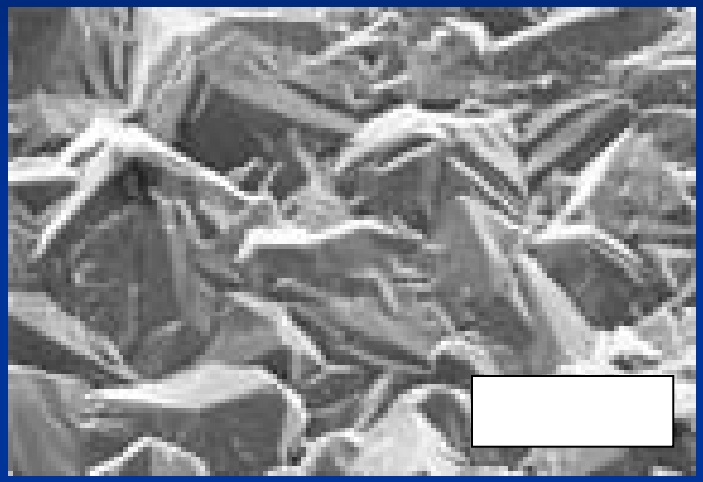
CVD Vale Ind. e Com. Ltda.

“in situ” Diagnosis - Laser Nd:YAG, Microwaves Reactor and Mass Spectometer

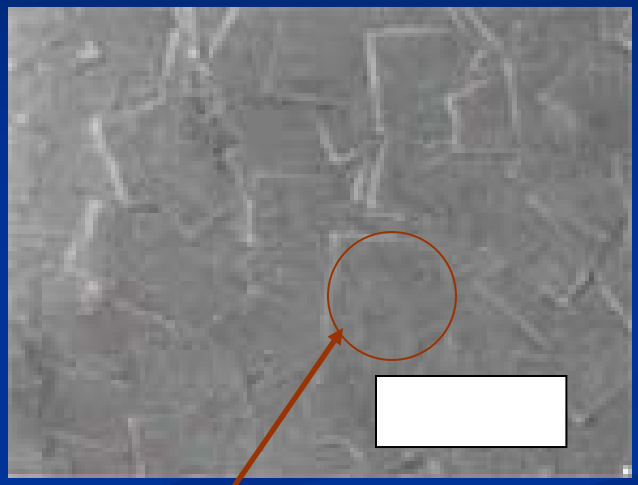


CVD-Diamond Morphology

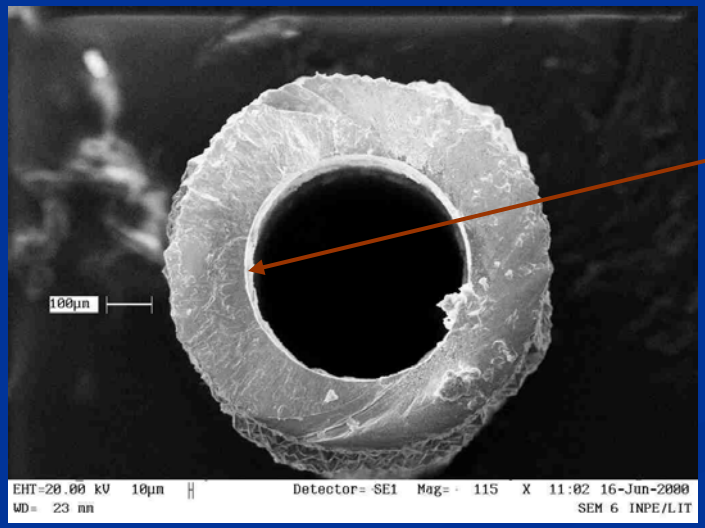
(111) Surface



(100) Surface

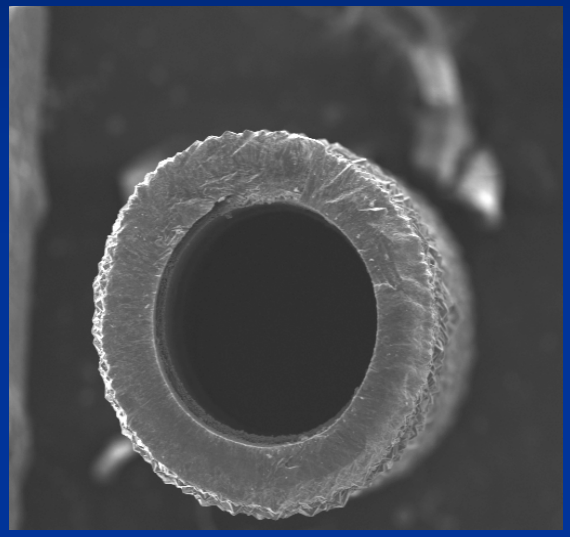


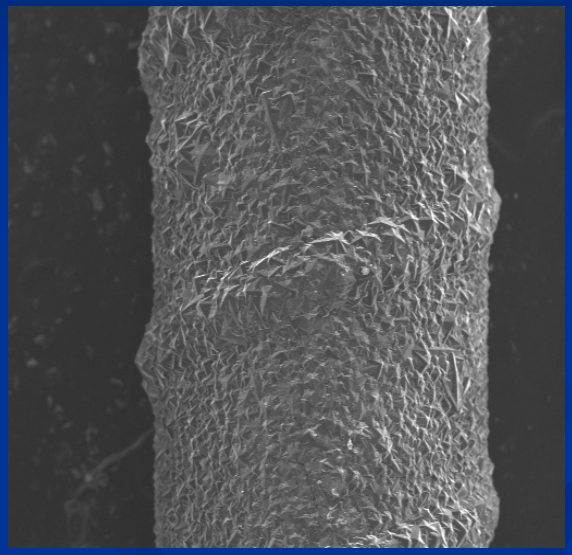
Analysis Region



CVD- Diamond Polished Surface

Diamond Tubes-CVD – Joint Development with NASA





Nanofabrication and Analysis of Nanostructured Materials

P.Is: Prof. Jacobus Swart –Eletrical Engineering and Computation

Prof. Newton Frateschi – Institute of Physics

Profs. Oswaldo Alves and Fernando Galembeck – Institute of Chemistry

UNICAMP

Focused Ion Beam/Scanning Electron Microscopy

FIB/SEM - U$ 1.000.000,00 – FAPESP August - 2006

Nanofabrication and Analysis of Nanostructured Materials

- Upgrading Nanolab-2000 (UNICAMP): producing and characterizing nano-structured materials (nanotubes and nanowires).
- Connections with "Instituto do Milênio - Tecnologias de Micro e Nanoeletrônica para Sistemas Integrados Inteligentes" e Instituto do Milênio de Materiais Complexos . (Cooperative Research).

Fiber-Optics Nano Sensors

Prof. Marcelo M. Werneck

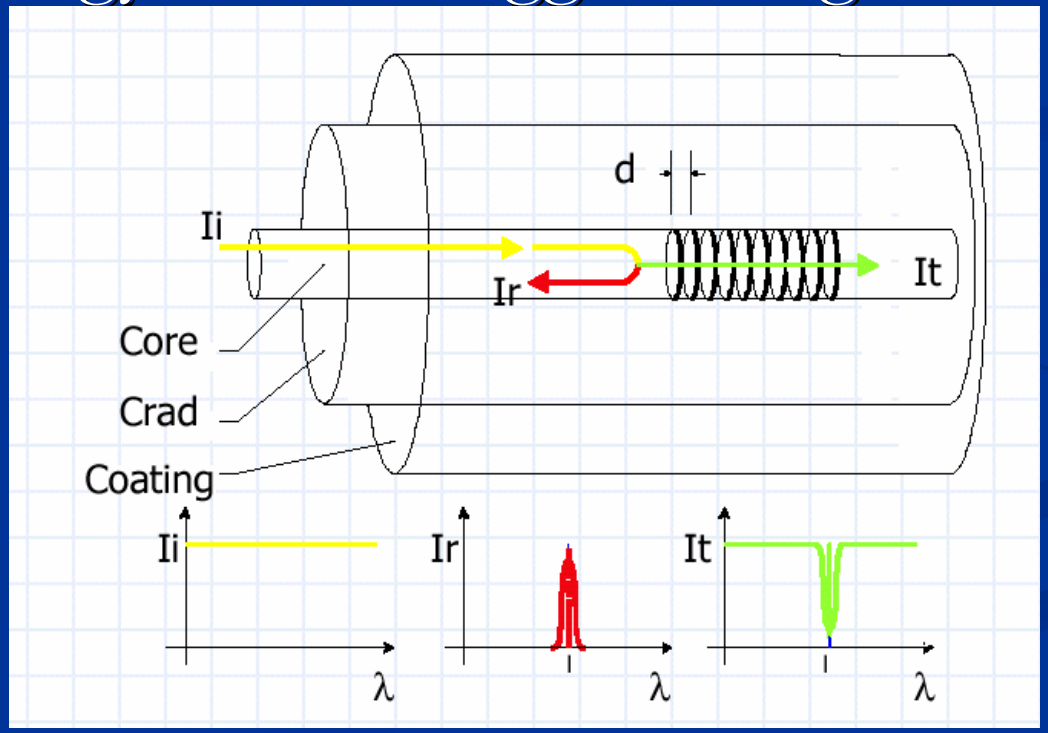
Eletrical Engineering Department
COPPE- Federal University of Rio de Janeiro

Research Areas

- Instrumentation
- Optoeletronics
- Fiber-Optic Sensors
- Biotechnology
- Transducers

Nano sensors

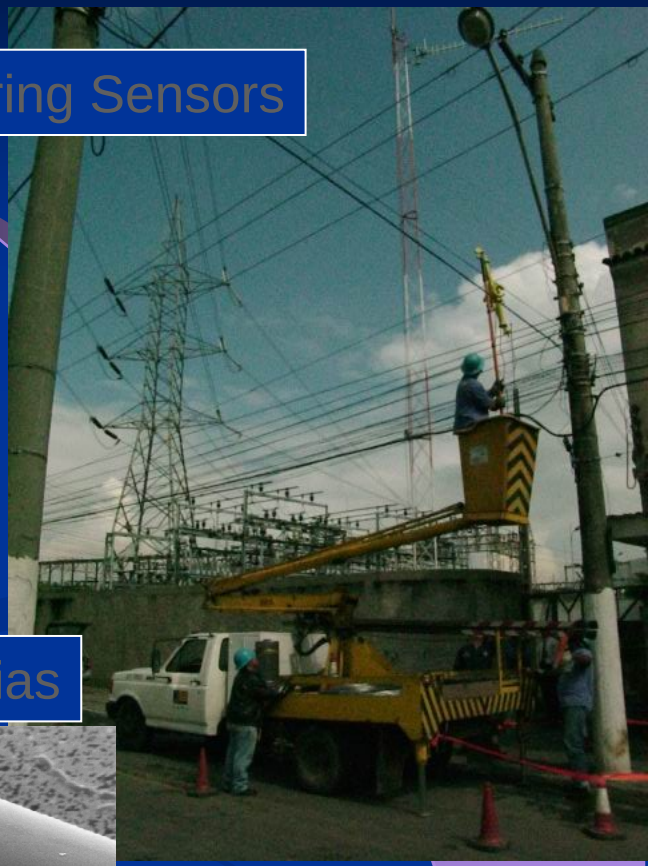
- Goal: Using photonics for monitoring high-voltage (750 kV) distribution lines and devices.
- Technology: Fiber Bragg Grating



Nanotech Prototypes

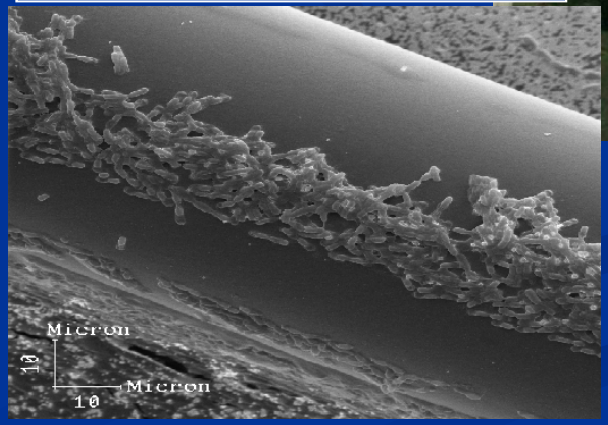
Gas Sensors

High Voltage Monitoring Sensors



Sensors for Oil Industry

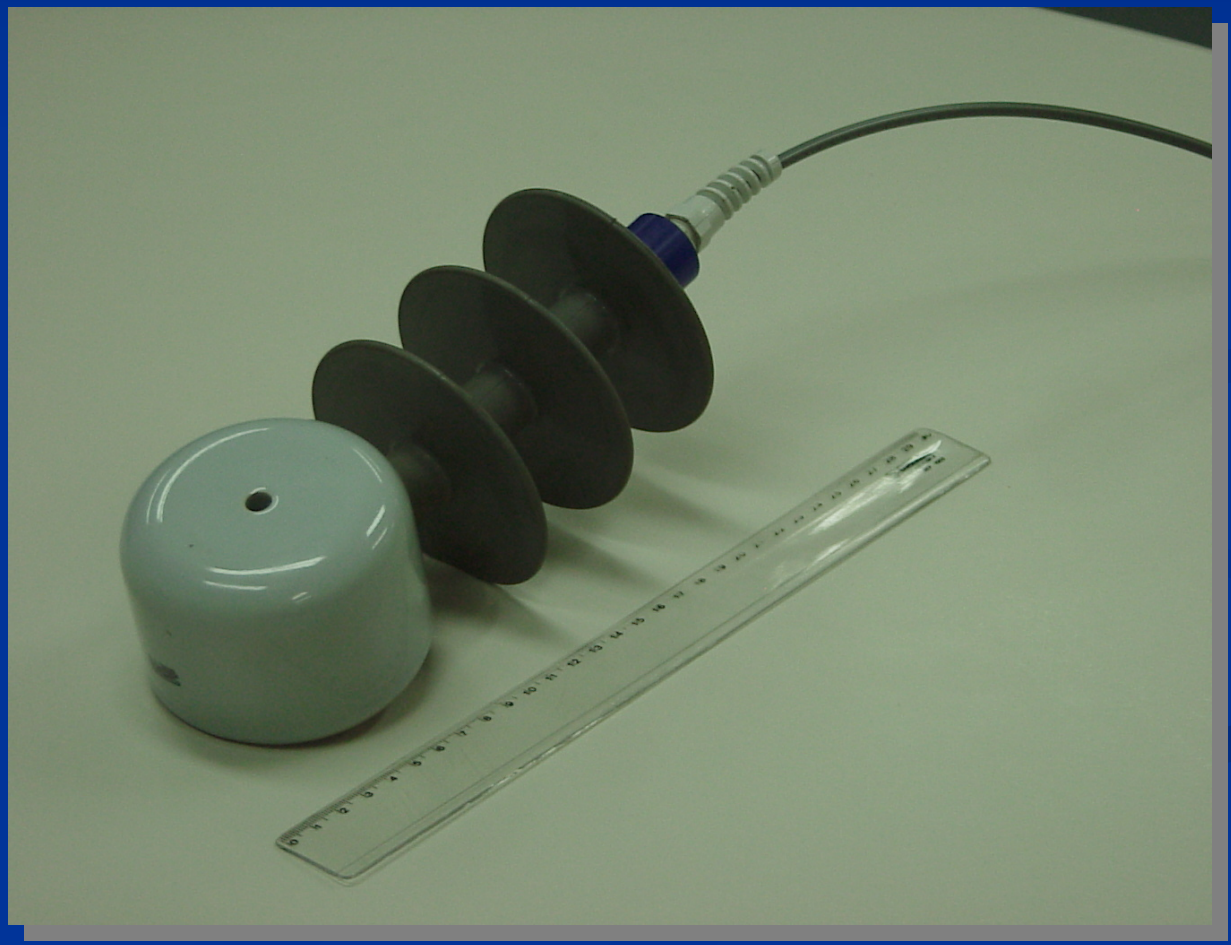
Sensors for Bacterias



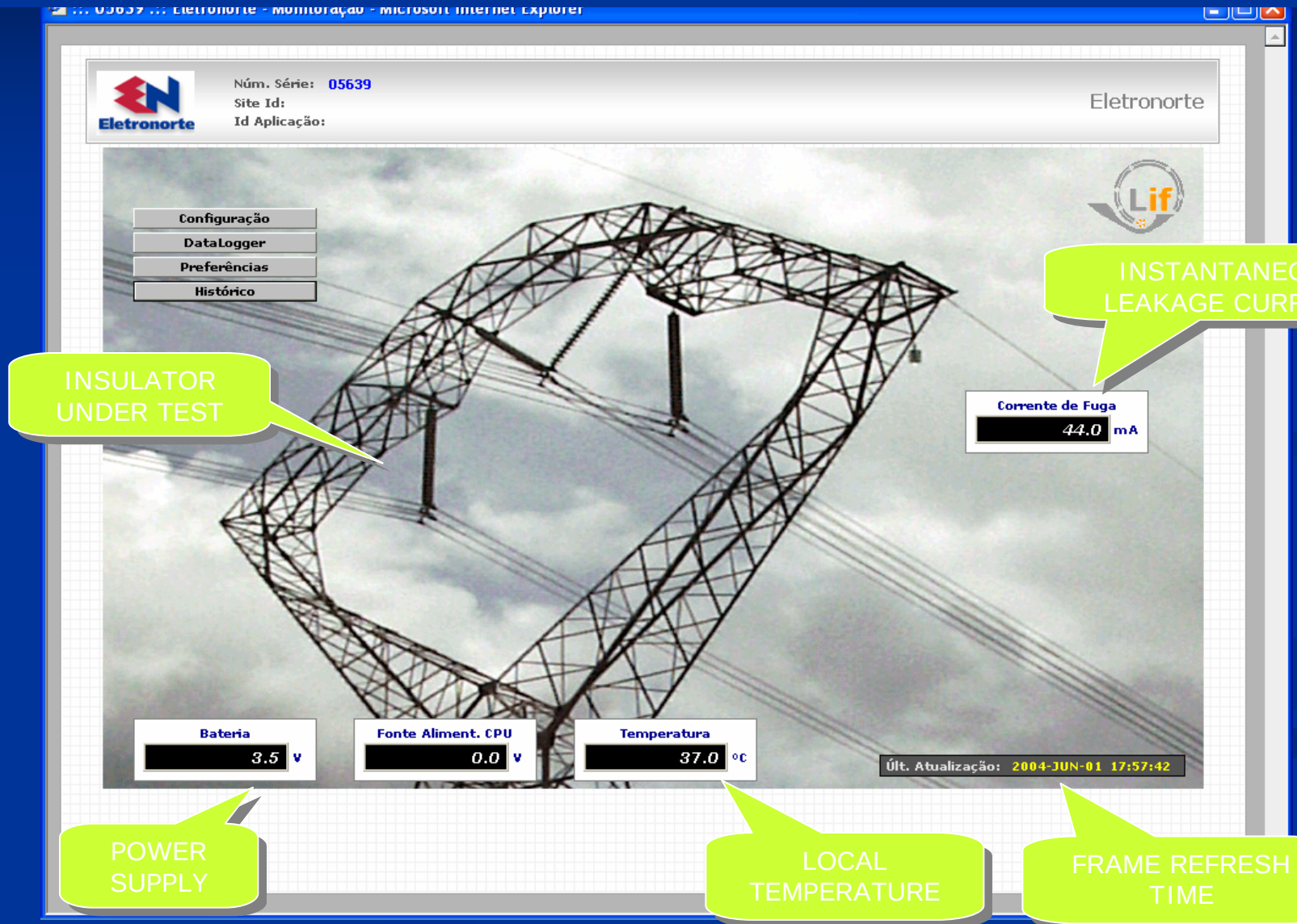
Field Operation

Measuring Current Leakage in 500 kV Transmission Line

Sensor Device



Monitoring the leakage from 4968 km



Research on Carbon Nanotubes

Prof. Marcos A. Pimenta

Department of Physics

Federal University of Minas Gerais

Synthesis (arc discharge and CVD): Luiz O. Ladeira, Rodrigo Lacerda, André Ferlauto, Sérgio de Oliveira (DF-UFMG)

Separation, purification and functionalization: Clascídia Furtado, Adelina Santos (CDTN-CNEN), Indhira Maciel, Flávio Plentz, Luiz Orlando Ladeira, André Ferlauto, Sérgio de Oliveira (DF-UFMG)

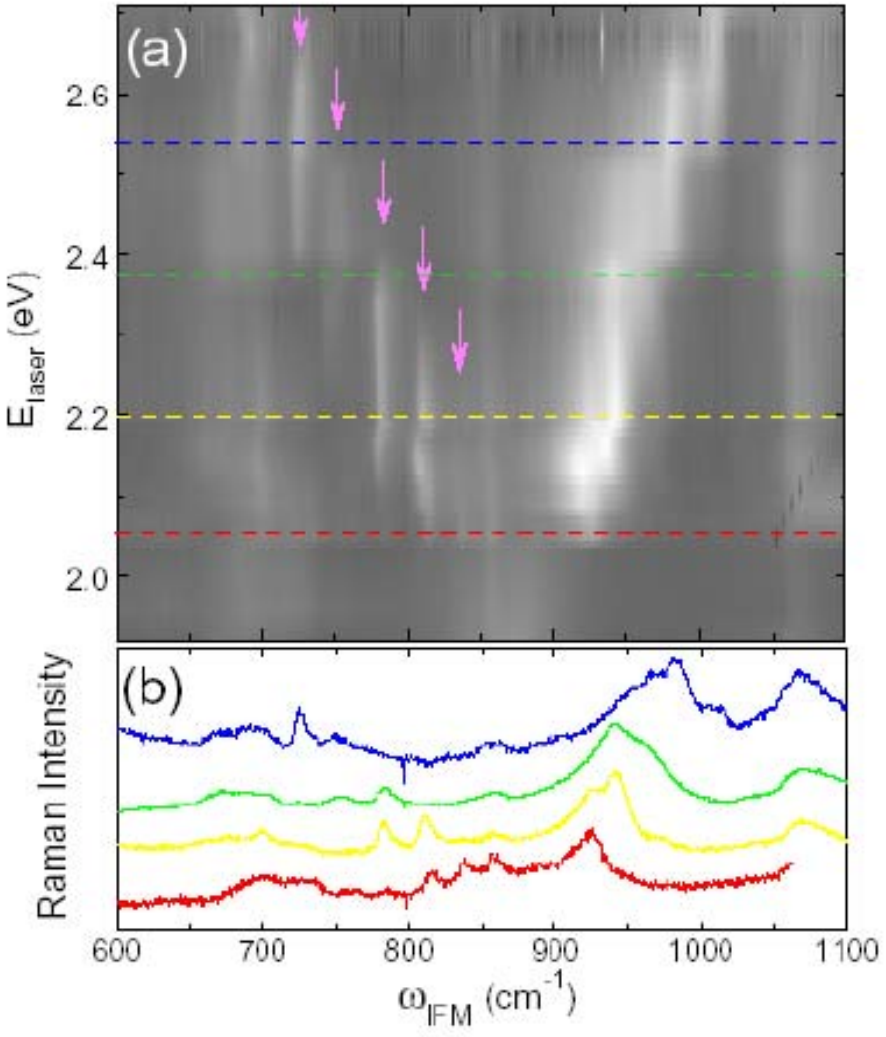
Raman Spectroscopy : Ado Jorio, Marcos Pimenta, Cristiano Fantini, Luiz Gustavo Cançado, Mauricio de Souza (DF-UFMG)

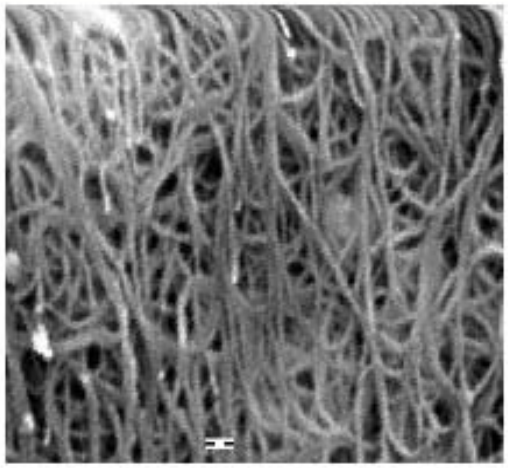
Photoluminescence: Flávio Plentz, Henrique Ribeiro (DF-UFMG)

Theory and modelling: Hélio Chacham, Ricardo W. Nunes, Mário Sérgio Mazzoni (DF-UFMG)

AFM and electronic microscopy: Bernardo Neves, Karla Balzuweit (DF-UFMG)

Resonant Raman scattering of the intermediate frequency modes in carbon nanotubes





$$\omega^{+}_{IFM} = \omega_O + \omega_A = \omega_O + v_A q$$

$$\omega^{-}_{IFM} = \omega_O - \omega_A = \omega_O - v_A q$$

$v_A = 2.2 \times 10^4$ m/s

(sound velocity in graphite)

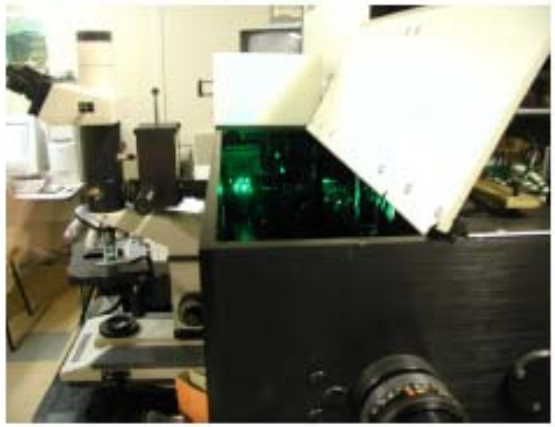
C. Fantini et al., Phys. Rev. Letters, vol. 93 (8), 087401 (2004)

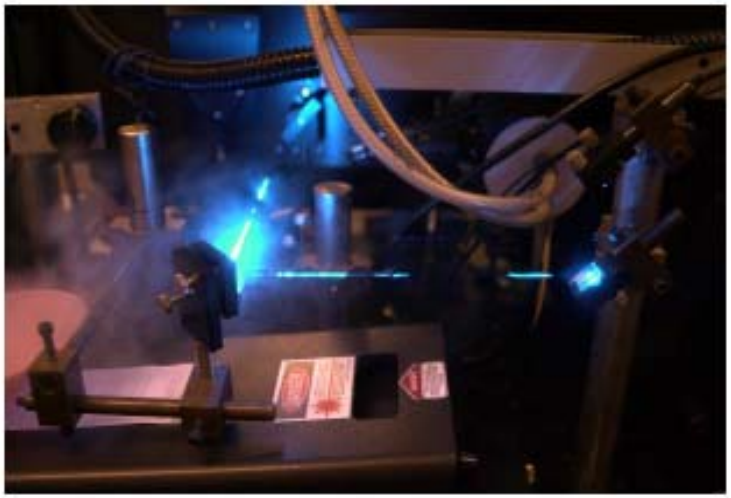
Resonant Raman Spectroscopy Laboratory, DF-UFMG

-Triple monochromator DILOR XY coupled to an optical microscope

-Ar-Kr laser

-Tunable laser systems (Dye- and Ti:Sapphire) pumped by an 9 W Ar laser





Trends, Next Steps and Challenges: The Near Future

- Discussing the improvement of Brazilian model (main issue: concentrating efforts in a National Lab x distributing the resources among the existing institutions).
- Extending the Program in the new PPA (2008-2011).
- Designing new paths for educating in the "new world" of Nanotechnology.

Trends and Next Steps: The Near Future

- Reshaping the System Profile: searching for balance between basic and applied research (general concern).

- Enlarging the participation and commitment of Industry and Private sectors. Petrobras elects Nanotechnology as a priority in R&D through a Thematic Network, involving: Federal University of Rio de Janeiro, Federal University of Rio Grande do Sul, UNICAMP, USP and Catholic University.

Nanocatalysis

Thematic Network – Petrobras - COPPE

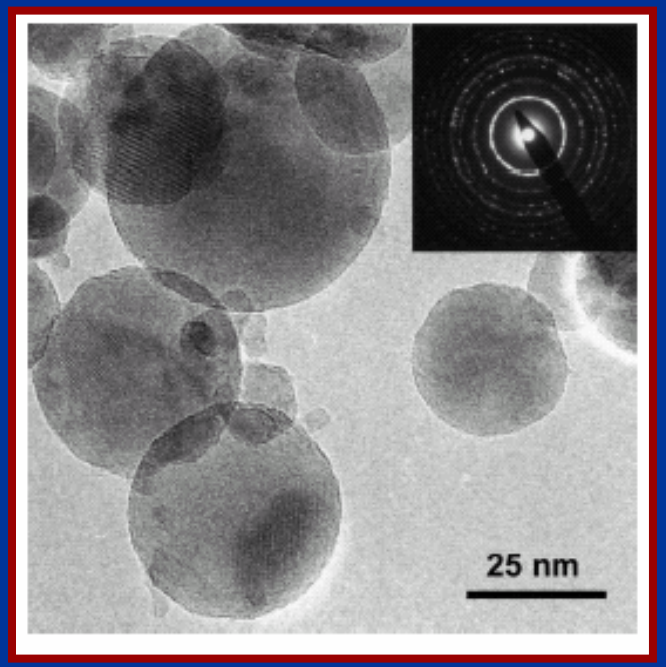
P.I. : Prof. Martin Schmal

Chemistry Engineering Department

COPPE/UFRJ

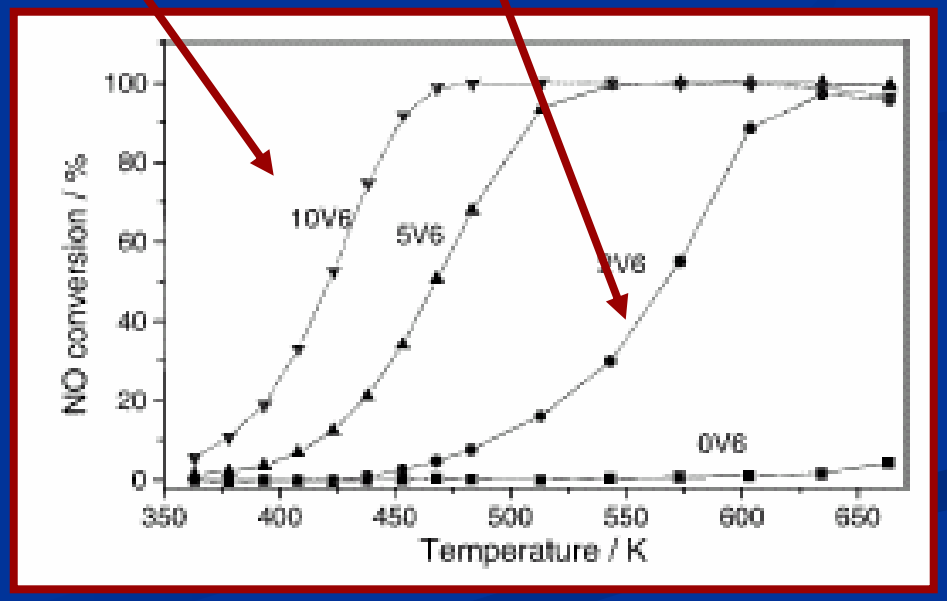
Micro and Nano particles

Converting NO in Vanádio/Alumina



Dp=13 nm

Dp=100 nm

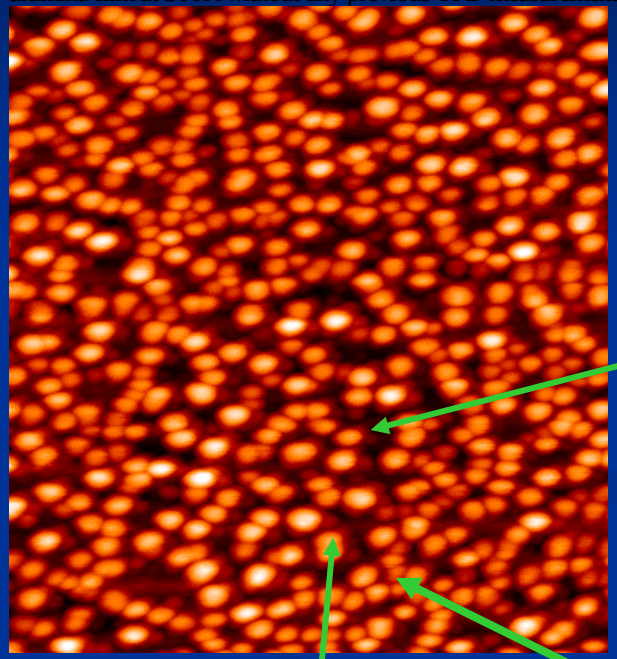


Baiker et al., Journal of Catalysis **197** (2001) 182–191.

CVD - Catalysis

- Bimetallic - system
- Co-Pd sobre Alumina 100;
- Imagens STM

Figure 6. 100nm x 100nm STM image of 2Å Co and subsequently 2Å Pd deposited on the alumina film at 300K without any previous TPD measurement.

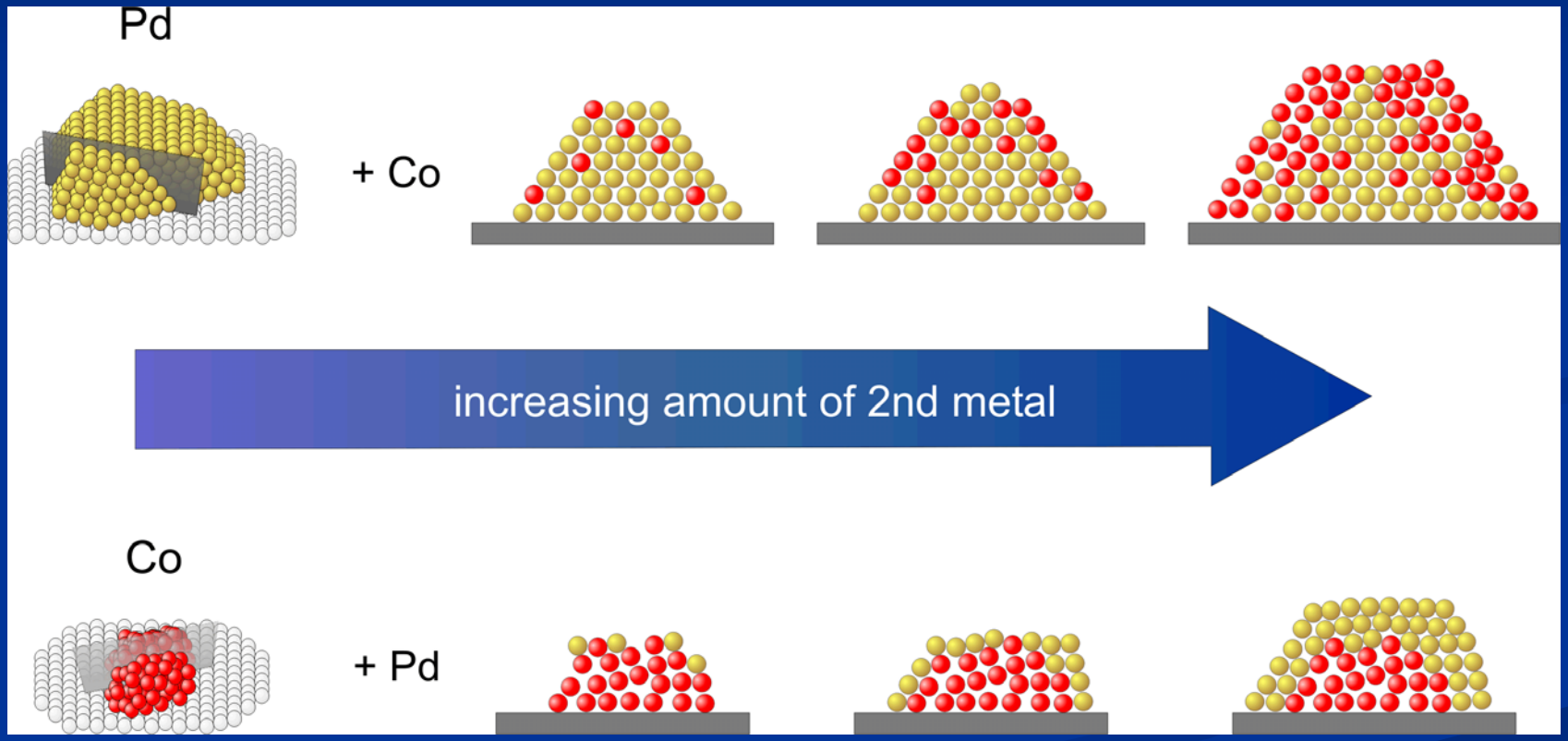


STM image of 2^0A Co and subsequently 2^0A Pd

A.F. Carlsson, M. Heemeier, M. Naschitzki, M. Schmal, M. Bäumer, H.-J. Freund, Angewandte Chemie 41 (2002) 4073-4076.
Max Plank – Fritz Haber Institut – Projeto conjunto CAPES/DFG

Co - Pd bimetallic particles

- structural model



A.F. Carlsson J. Chem. Phys. 119 (2003) 10885.

Nanoindentation and Multiscale Analysis of Geomateriais

P.I.s: Profs. Eduardo Fairbairn e Romildo Toledo Filho

Civil Engineering Department - COPPE/UFRJ

Multiscale Analysis of Creep in Concrete – Temperature Influence

P.I.s: Profs. Eduardo Fairbairn e Romildo Toledo Filho

Civil Engineering Department - COPPE/UFRJ

AFM for Coating Analysis and Design

Plasma Deposition on Oil Ducts

P.I.: Renata Antoun Simão

Thin Films Laboratory
Materials Engineering Department
COPPE - UFRJ

Nano-structured Coatings

P.I: Sergio de Souza Camargo
Materials Engineering Department
COPPE - UFRJ

New Facilities …

Visualization and Virtual Reality Center

P.I: Prof. Luiz Landau

Civil Engineering Department

COPPE - UFRJ