

## Associate Laboratories and Infrastructure

### Protective Coatings Laboratory (Physics Department, PUC-Rio)

The Protective Coatings Laboratory started its activities in 1994 and since then the focus of the research is on the production and characterization of hard coatings. Carbon and carbon alloys films (carbon nitride and carbon-fluorine films), boron carbide and titanium diboride coatings chemical, mechanical and tribological properties were investigated. Recently, also the study of multiwalled carbon nanotubes (MWNT) is on progress and the focus is on the doping of this material by boron, nitrogen and phosphorus atoms. The laboratory occupies an area of 150 m<sup>2</sup> in the Van de Graaff Laboratory building.

#### Infrastructure

For sample preparation we have the following systems:

- Thin film deposition chamber equipped with plasma assisted techniques (PECVD and dc or rf magnetron sputtering).
- System for MWNT growth by spray pyrolysis.
- CVD system for carbon nanotube growth (tubular furnace and controlled atmosphere up to 11000 C).
- Furnace for high vacuum or controlled atmosphere treatments (up to 9000 C).

For sample characterization the laboratory is equipped with:

- Nanoindenter TriboIndenter from Hysitron.
- Field emission scanning electron microscope (FEG-SEM) Jeol JSM 7600 F.
- NTEGRA Spectra AFM Raman from ND-MDT.
- Omicron ultra-high vacuum STM.
- Surface characterization system from Thermo equipped with an Alpha 110 analyzer.
- Microwear test system CALOWEAR from CSEM.
- Homemade goniometer for contact angle measurements.



STM



NTEGRA Spectra AFM Raman



Nanoindenter

## Materials Laboratory (University FEEVALE)

The researcher Cláudia Trindade Oliveira make use of the infrastructure of the Materials Laboratory, in addition to other laboratories at the University Feevale available to perform her research. In the materials laboratory, the equipments are located as follows:

- Potentiostat/Galvanostat AUTOLAB PGSTAT 302 with impedance modulo (FRA2) connected to a computer.
  - Multimeter AGILENT wiht 6 e ½ digits.
  - Voltage x current power supply, 20V, 2A.
  - Voltage x current power supply, 30V, 4A.
  - Voltage x current power supply, 300V, 0,5A
- (that will be acquired until the end of 2010).



Recently, the researcher acquired the equipments as follows:

- Oven until 1200°C.
- Oven with controlled atmosphere until 1000°C.
- Sanding machine.
- Polishing machine.

## LOFF - Laboratory of Optics and Thin Films (Physics Department, UDESC -Universidade do Estado de Santa Catarina)

### Facilities

One home made plasma enhanced chemical vapor deposition (PECVD) system with temperature control of the substrate holder, pressure gauges, power supply 1000V, 1A; and mass flow controllers. The micro processing system control all stages of the film deposition process.

At UDESC others facilities are accessible as scanning electron microscopy, electron dispersive x-ray spectroscopy, Fourier transform infra-red spectroscopy and sample preparation room.



PECVD system at the LOFF. 60 m<sup>2</sup> is the total area of the laboratory. At the right side one see the students' room, where two computers, 3 desks and one cabinet are available.

## Thin Film Laboratory (Physics Institute- UFF, Universidade Federal Fluminense)

The laboratory has two main research objectives: the study of plasma deposited a-C:H films (DLC films) and the study of nanostructured metal oxide films deposited by laser ablation.

### Laboratory facilities

#### Plasma deposited a-C:H films:

- Plasma deposition system, consisting of cylindrical SS vacuum chamber, high vacuum pumps, 4 gases admission system with mas flow controlers, absolute pressure measurement by capacitive manometer, 600 W RF power supply with automatic impedance matching network. All the system is interfaced with a personal computer in order to allow automatic control of the experiments. Film growth is probed by in-situ, real-time, near-normal laser reflectance, in order to determine the optical constants and film growth rate. (Fig. 1)
- CETR universal tribological test machine, capable of pin-on-disk, reciprocating and scratch tests in two normal force ranges 5-500 mN and 0.5 – N. The system is equipped with chamber for measurements in ambient atmosphere, liquid medium, and controlled atmosphere. (Fig. 2)

#### Nanostructured metal oxide films deposited by laser ablation:

A new deposition chamber is under construction, consisting of a spherical SS chamber equipped with multi-target holder, load-lock chamber, mass spectrometer for plume analysis and high density plasma source. (Fig. 3)



Plasma deposition system



Tribometer



Spherical chamber for laser ablation  
(to be assembled)

## LAS- Materials and Sensors Laboratory (INPE – Instituto Nacional de Pesquisas Espaciais) and R&D Laboratory at Clorovale Diamond S.A.

Related to Surface Engineering, we have many reactors at INPE and at Clorovale Diamante S.A. Also, concerning characterization, we have a new laboratory at INPE for tribological measurements.



PECVD System at INPE for DLC Growth



PECVD System at Clorovale Diamante



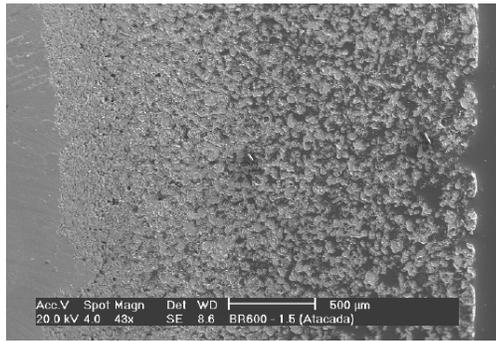
Tribological Characterization System from CETR

## Plasma Materials Processing Laboratory (UFRN – Universidade Federal do Rio Grande do Norte)

The Labplasma aims to develop research using plasma as energetic source to materials processing. It currently occupies an area of 150 m<sup>2</sup>. Initially, our researches converged to understanding of plasma nitriding process, working with carbon, tools and stainless steel, beside it had developed critical analysis of plasma nitriding performance on the complex geometry workpieces. A new process was developed in our laboratory, called Cathode Cage Plasma Nitriding (CCPN) where problems as edge and overheating were solved. From 1998 until now the Labplasma have been interacting with different Brazilian research groups, expanding research to other lines as:

### Heating of solids immersed in plasma:

Experiments carried out at our laboratory on samples of Cu-10% Al micro-alloyed powders; it was found which those samples when heated by plasma resulted in a microstructure porous on surface but dense in the core. The conclusion of this study showed which the phenomenon occurs due to the fusion of particles of the surface which diffuse by capillary to the nucleus of the material. Based on such studies, it was created a research line in a systematic methodology in order to study the heating of solids with different plasma configurations, such as: planar discharge, (ii) hollow cathode discharge and (iii) Atmospheric microwave discharge.



### Plasma reduction of metal oxide

Reduction is done by the aluminothermic process, where metallic oxide (Ta<sub>2</sub>O<sub>5</sub>, TiO<sub>2</sub>) mixed with Al stoichiometric proportion using high energy milling, is treated by hollow cathode discharge of H<sub>2</sub> atmosphere or plasma spray of argon atmosphere. Thermal peaks are generated due to the collisions of energetic species contained in the plasma. These peaks trigger the reaction in particle individually.

### Functionalization of surfaces for tribo-mechanical applications:

In this research line, we have studied thermochemical treatments such as nitriding, oxynitriding, carbonitriding of steels and refractory metals (Ta, Ni and Ti). In this moment a systematic study about titanium modification by interstitial elements plasma (Ar, N<sub>2</sub>, O<sub>2</sub>, CH<sub>4</sub> and H<sub>2</sub>).



### Functionalization of surfaces for biomedical applications:

In this research line are studied polymer surfaces (polyester, TNT, chitosan and cotton), metal (stainless steel, titanium) and ceramics (hydroxyapatite) modified by DC plasma and DC pulsed plasma. Surfaces are also produced with a gradient of porosity to be utilized as scaffolds for drug delivery and storage. Those surfaces are characterized by wettability measurement, DRX, microhardness assays and optical microscopy. The biological response of samples are evaluated through the adhesion and growth cell measurements. For applications such as scaffolds are evaluated size, shape and pore distribution as well as time-release drugs.

## Ion Implantation Laboratory (Physics Institute, UFRGS – Universidade Federal do Rio Grande do Sul)

The core of the laboratory consists of two electrostatic ion accelerators from High Voltage Engineering Europa. One of them is a 500 kV ion implanter, while the other one is 3 MV tandemron accelerator. Both machines provide a wide variety of positive ions in a broad energy range. Several beam lines with different analytical techniques are available to scientists from different fields. The techniques are:

- PIXE (Particle-Induced X-ray Emission): provide elemental concentrations of the order of part per million;
- RBS (Rutherford Backscattering Spectrometry): used for characterization of different structures, including multi-layered targets;
- NRA (Nuclear Reaction Analysis): ideal for profiling and studies of elemental distribution;
- Microprobe: allow the use of techniques like PIXE, RBS and STIM with micrometer beam size;
- MEIS (Medium Energy Ion Scattering): it is a high-resolution RBS technique with isotope-separation capability;
- Ion Implantation: used for modification of materials under controlled parameters.

The infrastructure of the laboratory includes a large variety of charged-particle, X-ray and gamma detectors, modular electronics, ovens and other related equipment. A fully-dedicated workshop allows the maintenance of the laboratory in a regular basis. A general view of the laboratory is shown below, featuring the beam lines of the Tandetron accelerator.



## Laboratory of Solid Surfaces and Interfaces (Physics Institute, UFRGS – Universidade Federal do Rio Grande do Sul)

### Facilities

Ultrahigh-vacuum surface characterization system (Omicron Nanotechnology) equipped for low energy ion scattering (LEIS) and photoelectron spectroscopy with X-rays (XPS) and ultraviolet radiation (UPS).



## Nanofabrication Laboratory (Physics Institute, UFRGS – Universidade Federal do Rio Grande do Sul)

### Facilities



Jeol JIB-4500 combined scanning electron microscope and focused ion beam instrument equipped with nanomanipulator and X-ray microanalysis (EDS)



Jeol JIB-4500 combined scanning electron microscope and focused ion beam instrument equipped with nanomanipulator and X-ray microanalysis (EDS)

## Ziegler-Natta Catalysis Laboratory (Institute of Chemistry, UFRGS – Universidade Federal do Rio Grande do Sul)

The Ziegler-Natta catalysis Laboratory disposes of the facilities necessary to conduct the catalyst/sorbents/sensors synthesis, characterization and evaluation. There are several devices for supports treatments, glove boxes for the manipulation of air-sensitive materials, reactor for supercritical drying, polymerization reactors. In terms of materials characterization, infrared and ultraviolet accessories for solid analysis (PAS, DRIFTS, DRS, for instance) and nitrogen porosimetry are available. The members have also access to atomic force microscope, ion beams analysis and electron microscopy center of UFRGS.



1 and 2 Büchi reactor



supercritical drying



nitrogen adsorption (BET method)



Thermal treatment system



Parr reactor

## Surface Engineering Laboratory (UCS - University of Caxias do Sul)

The Laboratory develops research activities following three different topics:

- Plasma surface treatment of metals.
- Plasma surface treatment of polymers and ceramics.
- Nanostructured protective coatings.

And it is equipped with different plasma based systems, all designed in house, like plasma nitriding by pulsed dc bias, rf and dc sputtering and ion plating.

The students and researchers of the surface engineering Laboratory have access to a last generation experimental facilities for material characterization, including, FTIR spectrometer, X-Ray diffractometer and scanning electron microscopy.



Ion plating system



SEM microscope



Infrared Fourier Transform Spectrometer - FTIR (Perkin Elmer)



Industrial plasma nitriding furnace at a spin-off company

## Surface Phenomena Laboratory (Mechanical Engineering Department, USP - University of São Paulo)

The Laboratory develops research activities following two research lines:

- Surface phenomena: friction, wear, lubrication and corrosion.
- Control of such phenomena through: (a) numerical modeling, (b) material and coating selections; (c) modifications in design and manufacturing processes.

### Facilities

- Wear test equipments
- Abrasion (ball mills, jaw crusher, rubber wheel, micro-abrasion – calo-wear – test with constant force or constant pressure)
- Instrumented press to analyze friction during forming operations
- Erosion
- Dry and lubricated sliding wear
- Contact fatigue
- Rubber tire wear
- Cavitation
- Corrosion test equipment: potentiostat
- Heat treating furnaces
- Roughness measurers
- ABAQUS Software (FEM)
- Material characterization equipments: optical microscopes, durometers, instrumented microdurometer, atomic force microscope-AFM with nanoindentation and nanoscratch testing devices
- Data acquisition systems for machining tests
- Turning and CNC milling machines



## Laboratory of Photovoltaic Research (Institute of Physics, UNICAMP – Universidade Estadual de Campinas)

The infra-structure of the Laboratory of Photovoltaic Research includes facilities for the development of solar cells based on crystalline silicon and several deposition systems for the development of thin amorphous films.



Facilities for the development of amorphous thin films using: Filtered Cathodic Vacuum Arc (FCVA), Plasma Enhanced Chemical Vapor Deposition (PECVD), ion gun, electron-beam



laboratory for the development of crystalline silicon solar cells.



Dektak perfilometer



Nanoindenter



Thermomechanical properties

## **POLIMAT - Group of Studies on Polymeric Materials (Department of Chemistry – UFSC – Universidade Federal de Santa Catarina)**

This group develops activities related to the study and characterization of polymeric systems and preparation of new materials since 1994. The main research fields of the group include the development of biofilms and nanostructured systems for food packaging and drug delivery.

The available physical infrastructure includes laboratories with two hundred square meters for development, preparation of films and biofilms and nanostructured systems, as well as space for equipment, including: thermal analysis system, universal machine test, spin coating, infrared, computers and other small equipments. Multiuser equipments are also available: nuclear magnetic resonance, scanning and transmission electron microscopy, dynamic light scattering and nanozetasizer.



## **Microanalysis Laboratory (Physics Institute- UFRGS - Universidade Federal do Rio Grande do Sul)**

The laboratory develops research activities on:

- Plasma nitriding: processing and characterization of steel and titanium alloys;
- Tribology applied to automotive braking systems: tests and surface characterization;
- Microanalysis EDS quantification using certified standards; x ray mapping, dynamic microhardness, microRaman spectroscopy;
- Material characterization: Glancing Incidence X ray diffraction and X ray reflectometry, Mossbauer Spectroscopy;
- Mineral characterization: gems and jewels, zircon and monazites.

### **Facilities**



Ultra Micro Hardness Tester Shimdzu DUH2115



X-Ray diffractometer Shimadzu XRD 6000



Micro Raman Spectroscopy



Scanning Electron Microscopy Jeol LV5800