

Overview

CMEMS is a research center focused on the design, modeling, simulation, integration and fabrication of microsystems targeting preferentially biomedical devices. The organization of the center, supported by 5 laboratories, reflects the high level laboratory intensity of the center.

Research at CMEMS includes several activities, all with special requirements in terms of laboratory use. The Computational Design, Modeling and Simulation Lab (CDMSLab) is dedicated to the computational design, modeling and simulation of biomechanical systems, medical devices and systems to assist in medical diagnostic, rehabilitation and health care. This lab addresses issues related to the prediction of medical devices interaction with human body.

Research on novel key technologies and systems integration, for instance, uses silicon microfabrication technologies (thin-film deposition including sputtering, e-beam and evaporation, mask aligner, dicer, Silicon wet etching bath, Wire-bonding, spin-coaters and wet-benches) along with other microfabrication technologies such as laser micromachining, microcasting, microjoining, 3D printing or CNC micromachining and hybrid solutions, all available at CMEMS laboratories. This has a highly intense laboratorial activity since the fabrication of devices requires the use of specialized existing equipment - Micro Fabrication and Systems Integration Lab. (MFSILab).

Similarly, surfaces functionalization research activities require various chemical, electrochemical, physical, mechanical, and laser-based techniques - Surfaces functionalization Lab (SFLab).

The fabricated microdevices need extensive characterization, both at device (performed at Materials/Components Characterization Lab. - MCCLab) and application level (using the Applied Devices and Instrumentation Lab. - ADILab). Once again, characterization of microdevices is the type of activity that requires the use of lots of equipment and due to microsystems complexity, the characterization is also an intensive laboratory activity.

Services Provided

Thin-film fabrication (PVD, ALD, CVD)

Thin-films on rigid or flexible substrate: Metals (Pt, Al, Cr, Ni, Ti, Au, Ag, Sn, Li are the most common, but other metal can also be deposited), Oxides (SiO_2 , TiO_2 , Al_2O_3 , SnO_2 and others), Nitrides (Si_3N_4 , TiN, AlN), Si, Ge, Bi, Sb, Te (thermoelectric applications), LiCoO_2 and LiPON (lithium batteries). Co-sputtering and co-evaporation can create compounds with controlled composition. Annealing is available, during deposition or after, at Ar, O_2 , N_2 or vacuum.

Thin-film characterization

Electrical, Optical, Chemical and Mechanical characterization is available as service. Thickness, roughness, resistivity, *seebeck* coefficient, thermal conductivity, density and mobility of charges, breakdown voltage, refractive index, ionic conductivity, and ionic diffusivity are readily available. SEM, EDS, XRD, Raman, AFM, DSC, and other techniques are available through partners at same institution.

Photolithography or Direct Laser Writing

The photolithography can be available as a service separated from microfabrication. Users can bring their own masks, or it can be designed and fabricated in MEMS-Lab, or ordered in partners. Negative and positive photoresists are available, for specific applications.

Microfabrication (RIE, wet etching)

The microfabrication service includes photolithography, and etching. Wet-etching for Si in KOH, oxides in buffered HF, gold, aluminum, titanium, cChrome and nickel. Reactive Ion Etching will be also available, for higher aspect ratio structures.

Dicing saw

Dicing saw for precision cut of wafers in single dies. This equipment is also used for microfabrication of high aspect ratio micro-needles.

SU-8 and PDMS molding

SU-8 molding and PDMS structures for microfluidic devices: fabrication of those structures according to the design and layout required by the external person. Also, this infrastructure allows that our students from PDEBIOM and MNT master will have the excellent opportunity to work with these processes and learn these technologies.

Medical Imaging

The Medical Image area equipment (Ultrasound, Computed Tomography, Colonoscopy, is available for external institutions in educational proposes. Students from Biomedical Engineering Masters and Doctoral Programs can use this equipment.

CMOS circuits design and fabrication


Design and prototype fabrication of specific analogue and digital integrated circuits (ASIC), microelectromechanical systems (MEMS) and heterogeneous technologies, accessing the fabrication from tier-1 foundries.

Access conditions

A MEMS infrastructure, located at University of Minho and related with the microtechnologies in silicon will be available. University of Minho and UTAD members of the MEMS-Lab have free access without any limitation to the infrastructure. Also, investigators of external groups working in the same area can use these facilities by the way of acquisition of services.

Facilities

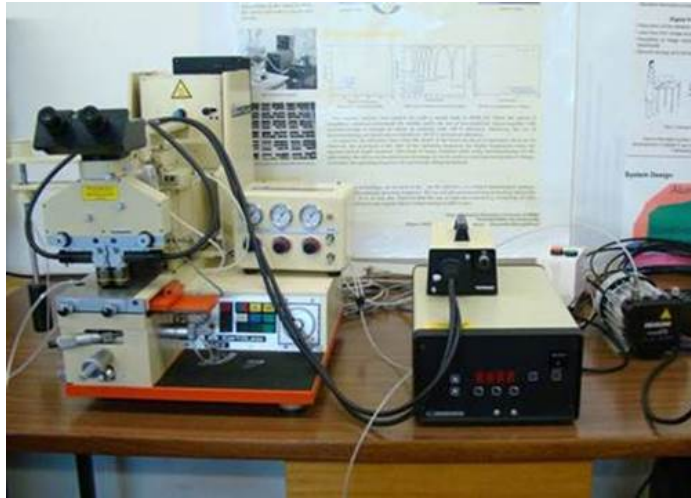
A complete infrastructure is available with equipment as: mask aligner, electron beam evaporator, dicing and saw system, spectrum analyser, computed tomography system, process bench for silicon wafers, spin coating for silicon wafers and respective oven for baking. This infrastructure is related with the microtechnologies in silicon. University of Minho and UTAD University are the participants and the infrastructure is located at University of Minho. Also, investigators of external groups working in the same area can use these facilities by the way of acquisition services, please contact Prof. Higinio Correia.

NAME	DESCRIPTION
Clean Cabin Class 100 (Burdinola BH-100)	<p>A class 100 clean room is obtained in a 2 square meters space, where equipment that needs a clean atmosphere is required. Usually is used for lithography.</p> 



**Mask aligner
(SUSS MicroTec)**

The photolithography bench has a Karl Suss mask aligner, with a 290-400nm UV lamp.



Wetbench with spin coating Polos

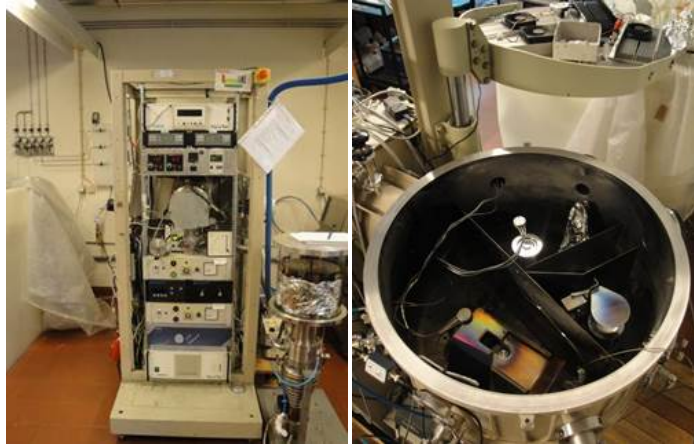
The Arias wetbench is prepared for acid manipulation, with vented air extraction. A spin coater (Polos), several hot-plates, DI water, N₂ gun and ultrasonic bath are available at wet bench.



**Multi process PVD deposition
system**

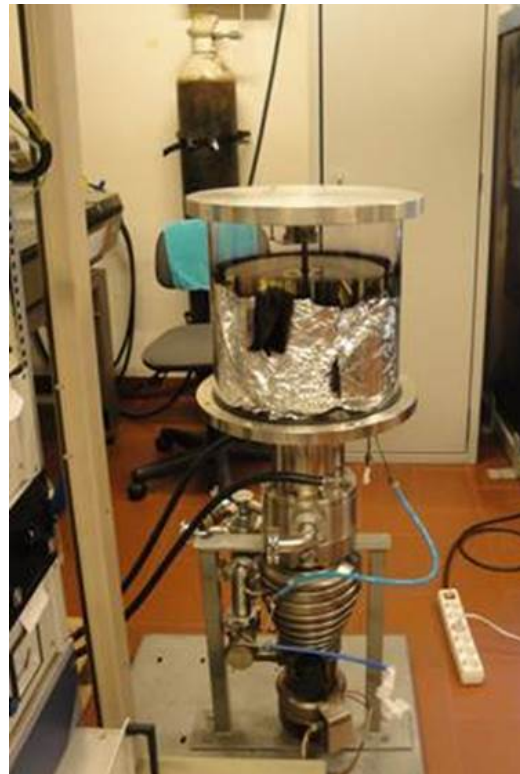
The PVD deposition system has two magnetron for RF and DC-sputtering, a multi-pocket e-beam with automatic pocket selection (model EV M-6), two thermal evaporation crucibles/filaments, in an ultra-high vacuum chamber. Two thickness controllers, Ar, N₂ and O₂ gas lines, heated substrate and rotating/positioning substrate holder

complements the deposition process.



Thermal coevaporator

This thermal coevaporator is prepared for deposition of materials that could contaminated the main PVD system, like gold, tellurides or other less common materials. Can be easily reconfigured for any material, and easily cleaned after use.



Probe station (Karl Suss AP4)

The probe station allows the micro-positioning of test leads on micro-fabricated circuits, for electrical characterization.





Endoscopic capsule system

The Given Imaging Endoscopic capsule system is used for integration of new functions like PDT, NBI or Zoom imaging. Images are transmitted on real time to a receptor near the patient.



Wirebonding system (SEMTEC)

The SEMTEC wirebonding system allows the connection of silicon die chips with chip package, other dies, or integrated microsystems, using gold wires. Includes a high magnification microscope and lens.



Tanner Tools Framework

This software tool is allows the design, simulation and generation of fabrication files of microelectronic circuits, using CMOS technology (or other).

Wafer automatic dicing saw (Disco DAD 2H/6T)

The micro dicing saw is used to cut whole wafer in single die chips. Cutting with from few micrometers to cents of micrometers is available.



**Silicon Bulk Micromachining
(TAMSOM T1000)**

Silicon bulk micromachining.

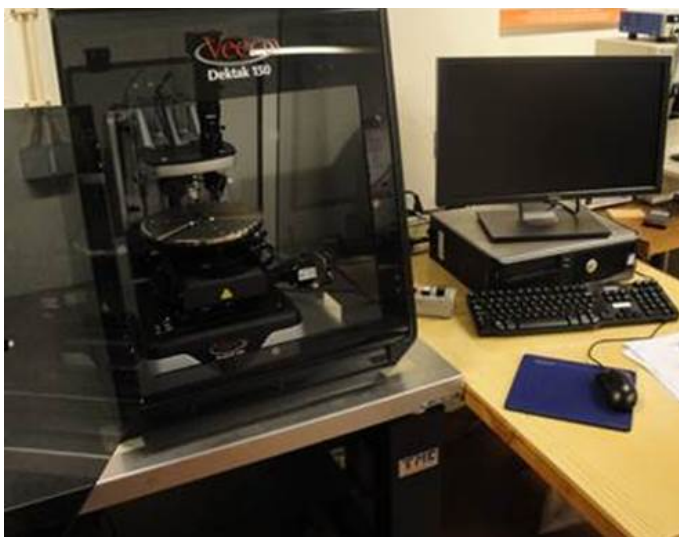
**Oven up to 1000 °C**

The full programmable oven can heat up to 1000 °C, with controlled heating/cooling ramps and cycles. Vacuum, Argon, Oxygen or Nitrogen is available for annealing processes.

**Profilometer
(Veeco Dektak 150)**

The Veeco Dektak 150 profilometer with two different sized stylus allows 3D characterization of surfaces, in a nanometer resolution.

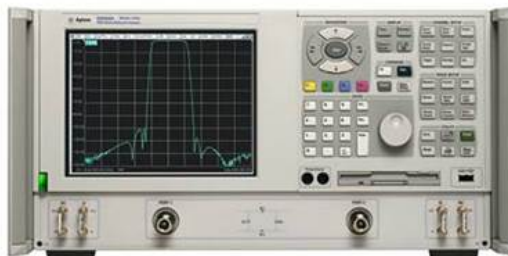


**Anechoic chamber**

Six square meter anechoic chamber for RF characterization.

**Network analyser**

Agilent, model HP-E8358A, 300kHz-9GHz.



Spectrophotometer
- Dual Monochromator (*Corner Stone 130 1/8 m*)

Two units *Corner Stone*, 130 1/8 m motorized, with Arc Lamp Housing 50-500W and QTH Lamp Housing 10-250W. Software for automatic operation.

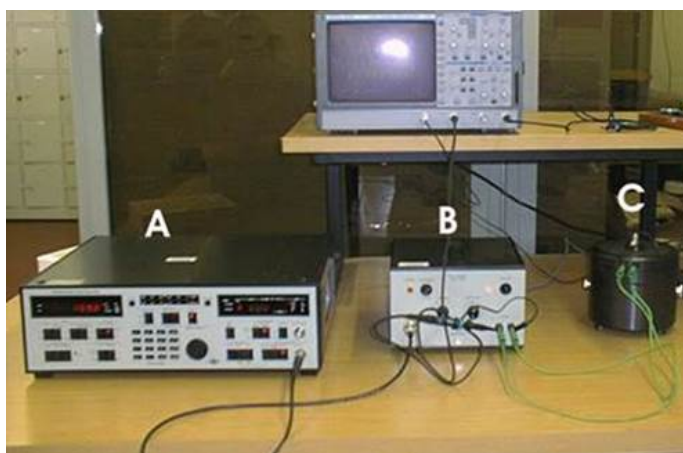


Electronic and bio-analytical measurement instruments and equipment

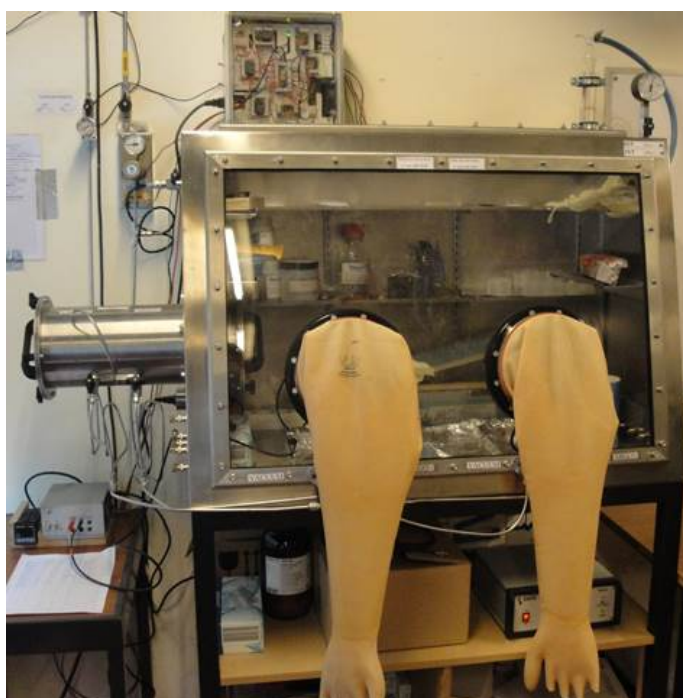

Multimeters (LG, Agilent 34410), Picoammeters (Keithley 6487), Signal generators, Oscilloscopes, Microscopes (Leica), spectrum analyser and other small bench instruments.


Accelerometer Test Bench

Accelerometer Test Bench.


Glove box

Glove box, with Argon atmosphere, load lock, and packing system.


Medical Imaging Equipment (Siemens Somatom Esprit)

The Computed Tomography and Ultrasound Imaging equipment supports advanced formation trough Doctoral

Program in Biomedical Engineering.

**Electrochemical characterization equipment (Gamry 600)**

Gamry instruments for Cycling Voltammetry, Electrochemical Impedance Spectroscopy and other electrochemical characterization, for liquid and solid electrolytes.

**Laser YAG 6W equipment**

Useful for micromachining (laser ablation), engraving and surface patterns creation



50-450 kHz, 50 W Ameritherm High frequency Induction heating device

Useful for sintering micro/nano reinforced components



Lampert Micro welding device



DWS Stereolitographic equipment

Useful for micro-prototyping



Expert Micro-machining CNC turning machine



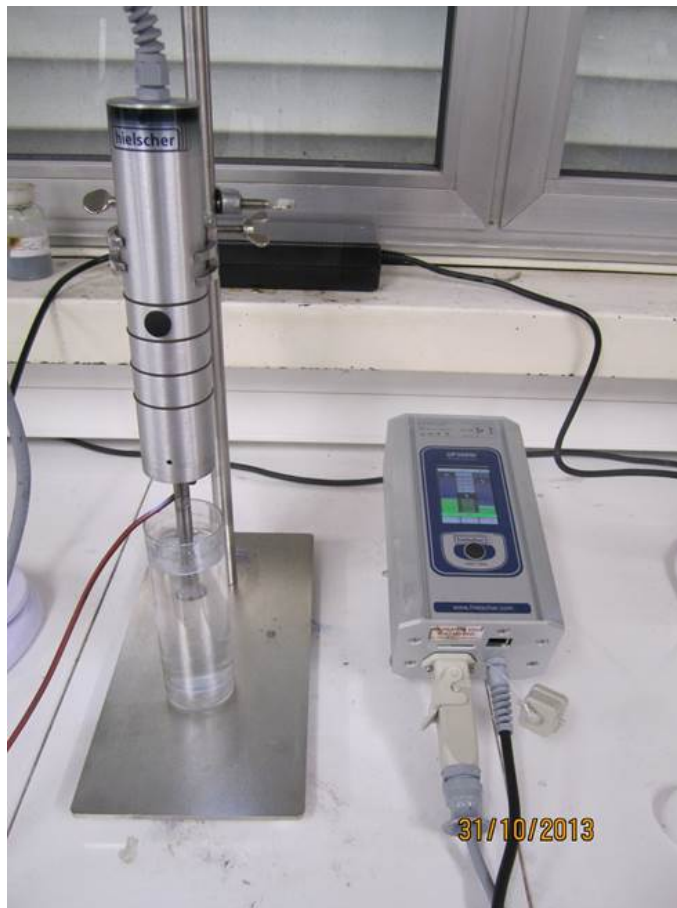
Roland 3 axes and 5 axes micro-milling equipments

Useful for plastics, ceramics and soft metals micro-machining



**Hielscher ultrasonic stirrer**

Useful for nano-particles dispersion

**Furnace** $T_{max}=1700^{\circ}\text{C}$; Vacuum $P=1\times 10^{-5}$ mbar

Gases: argon, nitrogen, oxygen

Useful for sintering or heat treatments



Zirkonzahn sintering furnace
 $T_{max}=1.700^{\circ}\text{C}$
Vacuum; protective gases (Argon)

Useful for metals and ceramics sintering.



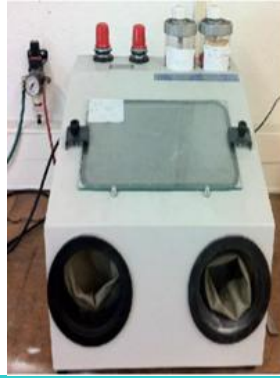
PVD sputtering machine

Useful for coatings deposition



Sand blasting device

Useful for surface mechanical treatment

**Indutherm Inducting microcasting machine**

Useful for microcasting by using the lost was casting process

**Linn High Term High frequency induction furnace:
Titancast 700 mP Vacuum**

Useful for centrifugal micro casting of titanium, and other alloys, by using the lost was casting process





Electrolytic deposition process

Useful for layered micro construction



Tribometer CETR-UMT 2 (pin-on-plate and pin-on-disc geometries of test)

Friction and wear tests at macro and micro scale



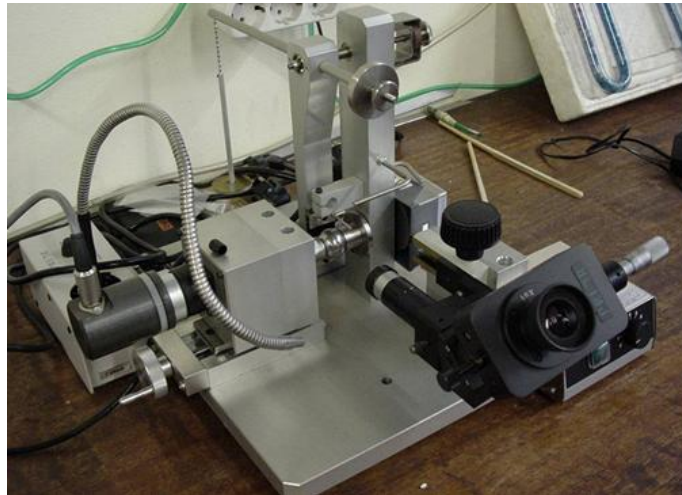
Tribometer Plint TE67-HT (pin-on-plate and pin-on disc high temperature machine)

Friction and wear tests at macro scale up to 600°C



Micro-abrasion test machine, Plint TE66

Abrasion tests at micro-scale



Microbalance METTLER

Accuracy of 10 μg



**MM ultrasonic system
(Multifrequency, Multimode,
Modulated Sonic & Ultrasonic
Vibrations)**

For degassing, homogenization and dispersion of nano and micro particles on molten alloys





Ultrasonic system (transducer, waveguide and sonotrode)

Machine for ultra grain refinement/microcrystallization of metallic alloys. Different waveguides/sonotrodes/clamping geometries can be used for other applications, like atomization of liquid metals for micro-sized powder production, stress relief, and so on.



Bottom loading muffle furnace

For thermal processing of ceramic moulds.
Useful for ceramic moulds processing.



DSC/TGA equipment

The equipment DSC / TGA simultaneously allows the determination of phase transformations that occur in materials as a function of temperature. The equipment works in inert or oxidizing atmosphere and permits thermal cycles up to 1500 ° C. The thermal analysis is used for characterizing the behavior of materials during the production and in-service.



Gamry Instruments – potentiostat/galvanostat (reference 600)

- Radiometer Analytical PGZ100
- Radiometer Copenhagen PGP 201
- Electrochemical characterization

Electrochemical characterization:

- Open Circuit Potential
- Electrochemical Impedance Spectroscopy
- Potentiostatic / Potentiodynamic Polarization

All the electrochemical tests can be done under simulated conditions (temperature, electrolyte and atmosphere).



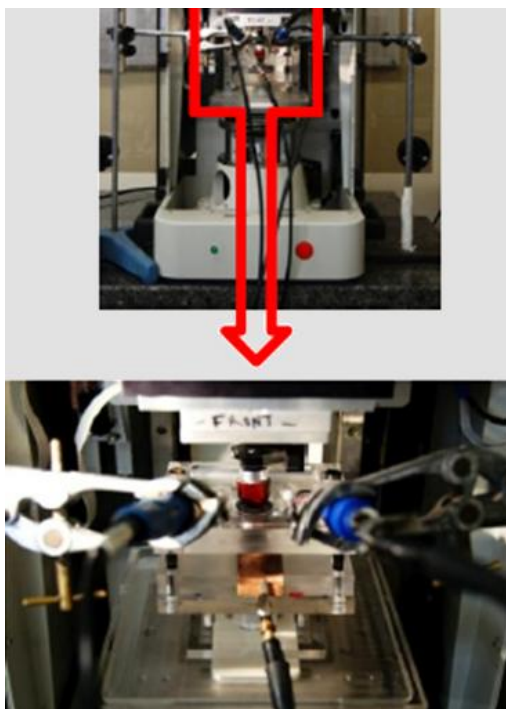
Tribo-corrosion setup

Tribo-electrochemical characterization:

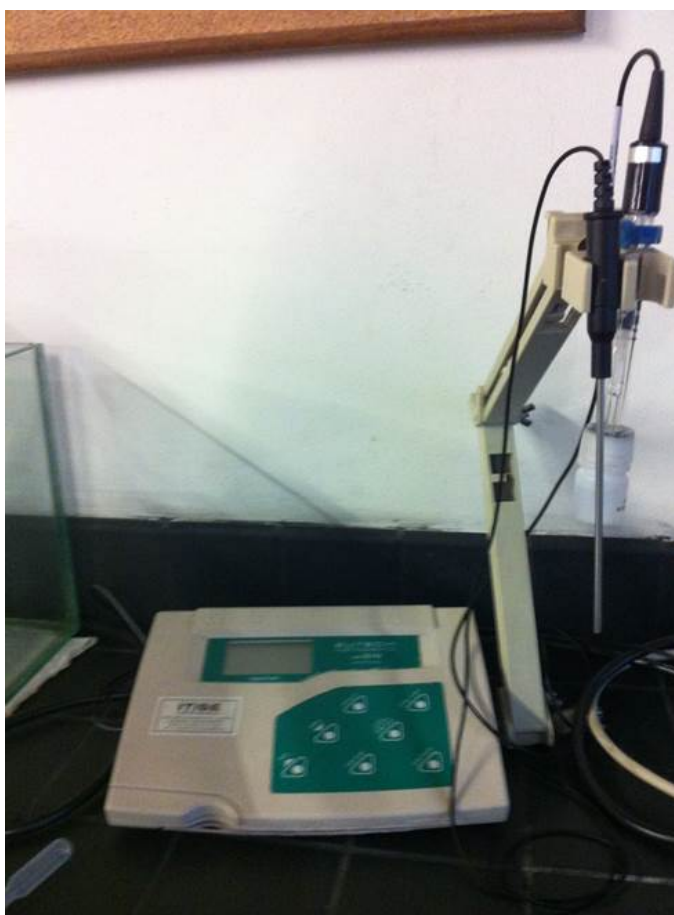
- Open Circuit Potential
- Potentiostatic / Potentiodynamic Polarization.

All the tribo-electrochemical tests can be done under simulated conditions (temperature, electrolyte and load). Biomedical applications the test can be done at body temperature ($37\pm 2^\circ\text{C}$) and in physiological solutions (PBS, HBSS, SBF, NaCl).





PH meter
Model EUTECH Instruments
pH510



DC power supply (GPR-30H10D)

Anodic treatments can be done under constant voltage or current.
 By anodic treatment surface modifications can be done at nano/micro scale.
 Depending on the base material, electrolyte, voltage, anodic treatment time different surface states can be reached.



**Micro-Hardness**

Emcotest Durascan Microhardness Tester

- Uniquely high test load range: 0.01-3 kgf

- Time saving with a maximum degree of automatic operation and fully automatic image analysis

Efficient data administration and customized data export.



Agilent E4404B ESA-E Spectrum Analyzer
9 kHz to 6.7 GHz

Key Features & Specifications

Speed

- (a) Frequency range from 9 kHz to 6.7 GHz
- (b) 0.4 dB overall amplitude accuracy
- (c) +16 dBm TOI
- (d) -167 dBm DANL, with internal preamp
- (e) 1 Hz narrow resolution bandwidth (optional)

Measurement applications

- (a) Phase Noise, Noise Figure, GSM/EDGE, cdmaOne and more view full list of measurement applications
- (b) Agilent's PowerSuite one-button power measurements included as standard

Features

- (a) 10 MHz analysis bandwidth
- (b) Segmented sweep for up to 32 discontinuous spans in one sweep
- (c) Rugged and portable for lab grade performance in the field
- (d) 5 minute warm-up to guaranteed measurement accuracy

Configuration selections

- (a) Standard express analyzer E4404B-STD for faster delivery time, includes options AYX, BAA.
- (b) Standard express analyzer with tracking generator E4404B-STG for faster delivery time, includes options 1DN, AYX, BAA.
- (c) Communications test express analyzer E4404B-COM for faster delivery time, includes options 1D5, 1DR, B7D, B7E, BAA.
- (d) Custom configuration for maximum flexibility with standard delivery time.