



POLITECNICO MILANO 1863

AMALA – Advanced MAnufacturing LAboratory

Available equipment

X-ray computed micro-tomography system for the analysis and 3D measurement of materials and structures

Available at Bovisa Campus

Department of Aerospace Science and Technology

Measurement and characterisation instruments

Name	Manufacturer	Model	Year	Technical specifications
SEM microscope	Hitachi	TM3000	2011	10000X tabletop scanning electron microscope
Optic microscope	Leitz		<2003	5/100x stereo optical microscope
Optic microscope	Nikon		<2003	20/1000x transmission optical microscope
Radiography system	GAMMATOM		<2003	RX radiography for material exam.70keV 5mA beryllium window 0.5x0.5
C-scan system	Gilardoni		<2003	Ultrasonoscopy system in immersion for composite laminates, probe 1-5-10 MHz
FO interrogator	CELM	OTTO	2010	4-channel opto-electronic system for fibre optic acquisition/interrogation
FO splicer	FUJIKURA	60S	2011	Fibre optic alignment/cutting/splicing/connection system (different diameters)
Piezo acquisition system	Smart materials		2008	Piezoelectric sensor power/acquisition system
SMA acquisition system	INSTEK		2008	Shape memory alloy actuator power/acquisition system
Thermal imaging camera	NIKON	LAIRD S270	<2003	Nikon temperature sensor system
Instron dynamometer	Instron	4302	<2003	1N/10kN test machine with thermostatic cell (-100 °C/+400 °C)
DMTA	TA Instruments		<2003	DMTA instrument (dynamo-mechanical-thermal analysis) trac., flex., 300 °C, 200 Hz
DSC	TA Instruments		<2003	DSC 500 °C calorimetry instrument
Rotational rheometer	TA Instruments	AR2000ex	2011	Rheometer/DMA 600 °C, 300rad/s
Viscometer	Brookfield		2003	Viscometer, viscosity 10/1000000 cPs
TMA/DSC	Mettler	TC11-TMA40-DSC30	<2003	DSC and TMA instrument to measure dilation coefficients
Tensiometer/contact angle	Lauda	TE3	2003	Contact angle measurement instrument, wettability, surface tension
1 mg analytical scale	Gibertini	Europe 500	<2003	Max 500g, resol. 1mg
Laboratory oven	Memert		<2003	250 °C
Vacuum oven	Heraeus		<2003	Laboratory oven 150 °C, with vacuum

Production and processing equipment

Name	Manufacturer	Model	Year	Technical specifications
Clean room	Novaria		<2003	clean room for composite laminates preparation - class 10,000 surface 5x5m
Refrigerator cell	Piardi		<2003	freezer cell for prepreg storage. Temp. -18 °C volume 10m ³
Autoclave	IROP		<2003	autoclave for composite laminates curing. 450 °C, 16bar, diameter 1m, length 1,5m
Autoclave update	IROP		2011	updated autoclave sw/hw
Polymerisation oven	CITT		<2003	Heated oven for large parts production. 180 °C 1x1x5m + pump for vacuum bag
Filament winding machine			<2003	3-freedom degrees machine, spindle lathe diameter max. 1m, length 5m.
Compression press	FASEL		<2003	Heated platens press 10 bar 220°C, platens dimensions 0.5x0.5m
Resin Transfer Mold	MVP	Hypaject MKIII	2011	capacity 5l, infusion pressure 8 bar

system.				
Compound cutting system	SCM- SIAT		2005	Composite materials cutting system with dust exhaust
Metallography polisher	Tecmet2000		2010	Polisher for metal and composite samples

Department of Mechanical Engineering

Measurement instruments

Name	Manufacturer	Model	Year	Technical specifications
Thermostatic chamber	Branca Idealair	2/S	2007	23 kW climatic element, Temperature 20 ± 0.5 °C (0.2 °C/h and 0.5 °C/m), relative humidity $45 \pm 5\%$
Coordinated measurement machine	Carl Zeiss	Prismo 5 VAST MPS HTG	< 2003	Measurement range 700 mm x 900 mm x 500 mm (Z) MPEP = 2.0 µm, MPPE = 2.0 + L/300 µm
Linear measurement machine	Microrep	DMS 680	< 2003	Measurement range 680 mm (absolute 100 mm), uncertainty 0.35 µm
Micro-measurement system	Alicona Imaging	IFM G4g System	2012	Lens 5x 10x 20x 50x 100x, uncertainty 0.5 µm
Presetting tool	Marposs	VTS	2012	Presetting system for micro-tools on the machine
Roughness tester	Mahr	PGK	< 2003	Stroke 20 mm
Roundness gauge	TSK	Rondcom 41A	2008	Stroke in Z 300 mm, part-holding table diameter 150 mm
Microscope	Leitz	Ergolux 200	< 2003	Lens 5x 10x 20x 50x 100x, binocular 10x
Stereo microscope	Leica	MZ75	< 2003	Lens 1x, zoom 0.63x-5x, stereo eyepiece 10x
Presetting	Speroni	STP 34	< 2003	For 40 and 50 tool holder as per ISO 7388
Thermal imaging camera	FLIR	SC3000	< 2003	320x240 pixel, wave length 8-9 µm, temperature range from -20 to 1500 °C
Triaxial load cell for shear force	Kistler	9257BA+5233A1	2011	Fx and Fy max: ± 5 kN, Fz max: -5/+10 kN
Triaxial load micro cell for shear force	Kistler	9317B + 5015A1000	2010	Fx and Fy max: 600 N, Fz max: 2000 N
Micro torque meter	Kistler	9329A + 5015A1000	2011	Max ± 1 Nm
Acquisition board	National Instruments	USB-6210 / PCI-6034E / PCI-6220	2008	4 acquisition cards 16 channels, 16 bit, 200000 or 250000 samples/s
Analytical scale	Precisa	100A-300M	2007	Max. capacity 300 g, resolution: 0.0001 g up to 200 g, 0.001 g up to 300 g

Production machines

Name	Manufacturer	Model	Year	Technical specifications
CNC lathe	Biglia	B 301	< 2003	Power 13 kW, Dmax workable 100 mm, tailstock distance 400 mm, tool holder: rod 20x20 mm or Ø 32 mm
CNC work centre	MCM	Connection Synthesis	< 2003	Power 25 kW, 4 pallet 500 mm x 500 mm, workable 250x400 mm on cube, tool holder: 40 ISO 7388
CNC rectifier	Rosa Ermando	IRON I 08.6	< 2003	Power 15 kW, table 500x300 mm
Water Jet cutting machine	Tecnocut	IDRO 1740	2005	Maximum pressure 370 MPa, work area 4000x1700 mm
5-axes microprocessing system	Kern	EVO	2008	Work area 150x150x200 mm, Tool holder: HSK E 25 modified Kern, precision 1 µm on part
Ultrasound metal welder	STAPLA	Albatros	2004	20 kHz generator
Ultrasound plastic welder	Sirius Electric	USPM-2020	2011	20 kHz generator
3 kW fibre laser source	IPG Laser	YLS-3000	2010	Power 3 kW, Class 4, wave length 1070 nm
1kW fibre laser source	IPG Laser	YLR-1000	2007	Power 1 kW, Class 4, wave length 1070 nm
Anthropomorphic robot	ABB	ABB IRB 4400	< 2003	Power 8.3 kW, elbow height 1.8 m
Anthropomorphic robot	ABB	ABB IRB 2400	< 2003	Power 4 kW, elbow height 1.6 m
Scanner head for laser	El.En.	ScanFiber F-theta lens 1000mm	2011	
Powerweld	Trumpf-Laser	PowerWeld	< 2003	Power 150 W (impulse 7.5 kW) impulse duration 0.3-20 ms, impulse frequency 600 Hz, Class 4, wave length 1064 nm
Microlaser system	IPG Laser	YLR-50	2007	Power 50 W
Parallel lathe	Fervi	T 660	2008	Power 750 W, bit height 130 mm, tailstock distance 500 mm, tool holder: rod 12x12 mm
Mill drill	Bianchini	Bimak 45	2008	Power 3 kW, table 660x200 mm, stroke 460x200x140(Z) mm
Band saw	Bianco	280 SA	2008	Power 1.67 kW, max 160 mm
Mechanical shear	Vibitech	Q11	2009	Power 7 kW, max thickness 3 mm, max sheet width 1200 mm

Department of Chemistry, Materials and Chemical Engineering

Microstructural analysis instruments

Name	Manufacturer	Model	Year	Technical specifications
SEM microscope	Zeiss	EVO 50XVP	2006	Scanning electron microscope (acceleration voltage: 200 V-30 kV)
	Oxford Instruments	INCA-Energy 200	2004	X-ray EDS microanalysis module
	Oxford Instruments	INCA-Crystal 200	2004	Electron Backscattered Diffraction System module
Optical microscope	Leitz	Aristomet	1992	Metallography optical microscope (25x-500x; brightfield, darkfield modes, polarized light)
	Leica	MEF4A/M	2000	Reversed metallography optical microscope (50x-1000x)
Stereo microscope	WILD Heerbrugg		1992	
	Leica MZ8	MZ8	2000	
Preparation laboratory			2000 2013	equipment system for material sample sectioning, embedding, sanding, polishing and etching for micro-structural analyses

Weight and surface chemical-physical analyses instruments

Name	Manufacturer	Model	Year	Technical specifications
Scanner differential calorimeter	Setaram	LabSYS DSC/TGA	2002	DSC and TGA thermal analysis system equipped with rods and oven for analyses up to temperatures of 800°C and 1600°C.
GDOES	Horiba Jobin-Yvon	GDP2	2007	GDOES system (discharge optical emission spectrometer) for surface or weight composition profiles with the simultaneous analyses of 19 different elements and dedicated UV lines for C, N, O
Micro-indenter / scratch tester	CSM Instruments	Micro-Combi Tester	2007	Micro-indenter equipped for hardness test, elastic modulus (load: from 0.01 to 10 N) and scratch tester (load: from 0.3 to 30N)
Micro-durometer	Future Tech	FM-700	2001	micro-durometer KV / HK with load from 1 to 2000 g
	Leica	VMHY30	2000	micro-durometer KV / HK with load from 1 to 2000 g
CSM tribometer	CSM Instruments	Tribometer	2011	Pin-on-disk/ball-on-disk configuration tribometer for wear tests on linings and mass materials (load 1-100 N, speed 0-600 rpm)

Department of Civil and Environmental Engineering

Name	Manufacturer	Year	Technical specifications
CMOS digital camera (1.3 Mb, uEye IDS) with long-distance ZOOM lens (Navitar 6000 modular zoom, with several adapters), traditional lens, tripod	IDS, Navitar	2008/2009	Digital image acquisition during experimental tests, with remote control and timed acquisition
Movement system with four freedom degrees (X,Y,Z,θ) and positioning bench for optical monitoring	Assembled by engineering firm	2010	The system (dimensions about 60x60x70 cm) is remote controlled by LabView software Each runner for movement on the surface has 25 cm stroke and micrometric precision. Vertical movement has a 30 cm stroke. Rotary part with resolution 0.1°
Oven with numeric control for temperature tests up to 300 °C, with front window for optical and thermocouple monitoring	Assembled by engineering firm on our design	2013	The reduced sized oven (70x70x60 cm) is moveable and positioned in a traditional mechanical test machine, and has an opening at the top for actuator insertion. The test chamber permits small sized samples to be tested (up to 10 cm diameter)
3 structures for micro test devices on site to be placed inside a tomograph, with various custom components and connections	Assembled by engineering firm on our design	2009/2011	Cylindrical elements assembled with screws and bolts, with equipped base and top to secure on the turntable, and discontinuous side surfaces in PMMA (low attenuation coefficient) various thickness and shapes according to applied loads
NEXLINE® N-216 High-Force Piezo Stepping Motor with controller and software, in catalogue	Physik Instruments	2010	Maximum uniaxial force 600 N, stroke 20 mm, accuracy 5 nm, integral derived control in closed loop
High load DC Motor M-238 K007 with MERCURY controller and software, built to order	Physik Instruments Not in catalogue	2010	Maximum uniaxial force 1000 N, stroke 10 cm, submicrometric accuracy, integral derived control in closed loop
Screw type Stepper Motor with controller and software, in catalogue	Physik Instruments	2009	Maximum uniaxial force 50 N in open loop, 20 mm stroke, micrometric accuracy
3 small load cells, one button mini in sole compression, and two bilateral (traction/compression) with 25 and 250 pound capacity, with NI acquisition board	Interface by Danetech	2009/2010	Cells to be used in load micro-devices. Data acquisition, display and saving via LabView programs.
INSTRON 8562 electromechanical machine with 100kN range, with control electronics and various load cells	INSTRON	<2000 Cell calibration (even with new acquisitions) and electronic update about every 5 years	Pre-damaging and load cycles

Electric ovens Tmax 850°C equipped with 950mm x 500mm x 400mm internal chamber	Assembled on our design TORNATI Forni	2009	Sample treatment with high temperature heat cycles
BINDER Tmin -40°C Tmax +180 °C climatic chamber and RH control	BINDER	2009	Sample treatment with heat cycles (tenth of a degree resolution)