UNIVERSITY OF RIJEKA

EQUIPMENT OF THE CENTRE FOR MICRO - AND NANOSCIENCES AND TECHNOLOGIES (CMNST)

Sveučilište u Rijeci
University of Rijeka

CENTRE FOR MICRO-AND NANOSCIENCES AND TECHNOLOGIES

Europska unija
Ulaganje u budućnost

STRUKTURNI I INVESTICIJSKI FONDOVI

KONKURENTNA HRVATSKA

Ministarstvo znanosti, obrazovanja i sporta

The project is co-financed by the European Union through the European Regional Development Fund.
www.strukturnifondovi.hr
The content of this publication is the sole responsibility of the University of Rijeka.

UNIVERSITY OF RIJEKA

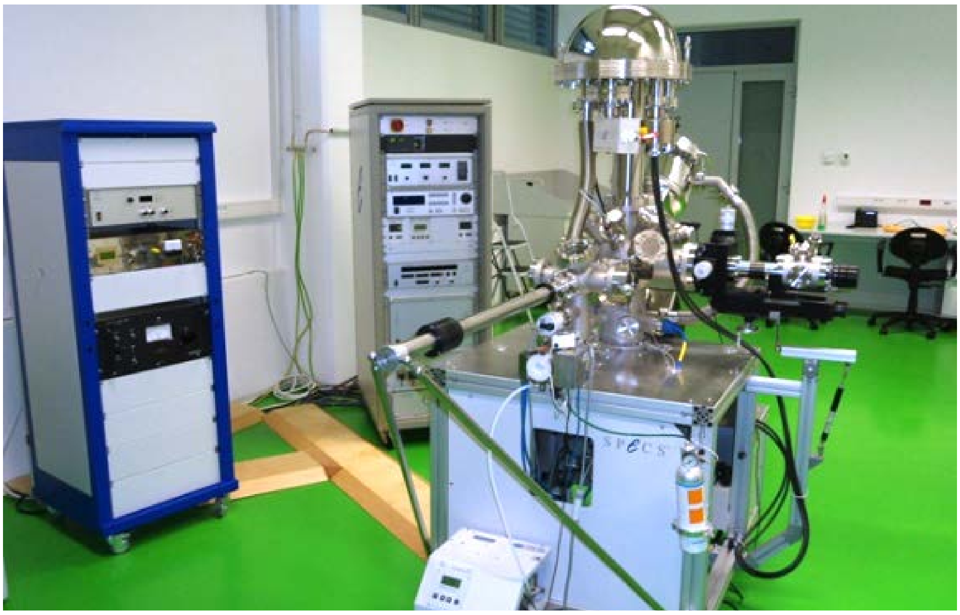
EQUIPMENT OF THE CENTRE FOR MICRO - AND NANOSCIENCES AND TECHNOLOGIES (CMNST)

Sveučilište u Rijeci
University of Rijeka

CENTRE FOR MICRO-AND
NANOSCIENCES AND TECHNOLOGIES

1

EQUIPMENT OF THE LABORATORY FOR SURFACE SCIENCE

Instrument	**X-ray Photoelectron Spectrometer (XPS)**
Laboratory affiliation	**Laboratory for Surface Science**
Equipment category	**Device for chemical and elemental characterisation of materials**
Photograph	
Short description	**X-ray Photoelectron Spectroscopy (XPS**) uses soft (low energy) X-rays for elemental and chemical characterization of the surface of material
Main purpose	The X-ray beam excites the electrons of the sample atoms and if their binding energy is lower than the X-ray energy, they will be emitted from the parent atom as a photoelectron. Only the photoelectrons at the extreme outer surface (10-100 Angstroms) can escape the sample surface, making this a surface analysis technique. XPS provides elemental information, but because the technique is detecting the binding energy of emitted electrons, it can also provide some chemical bonding information. Depending on what elements the parent atom is bound to, the binding energy of the emitted photoelectrons may shift slightly. The instrument is sensitive enough to detect these electron energy shifts and use them to determine what chemical compounds are present.
Technical specifications	X-ray Photoelectron Spectrometer is a SPECS system equipped with: ■ X-ray source with monochromator (FOCUS 500) - Al Kα (1486.74 eV) or Ag Lα (2984.3 eV) ■ hemispherical electron energy analyser (PHOIBOS 100 MCD-5): ■ electron gun (FG 500) ■ ion gun for low-energy ions of inert and reactive gases (IQE 11/35) ■ ion gun for low-energy ions with differential pumping (IQE 12/38) ■ Residual Gas Analyser, RGA (Prisma Plus QMG 220)
Additional information	http://phy.uniri.hr/en/divisions-and-laboratories/102-en/divisions-and-laboratories/division-of-experimental-and-applied-physics/801-xps.html
Year of manufacture	2009
Source of founding	Croatian Science Foundation
Contacts	Assoc. Prof. D. Sc. Ivana Jelovica Badovinac (+385 51 584607, ijelov@uniri.hr) Assoc. Prof. D. Sc. Robert Peter (+385 51 584621, rpeter@uniri.hr)

Instrument	**Secondary Ion Mass Spectrometer (SIMS)**
Laboratory affiliation	**Laboratory for Surface Science**
Equipment category	**Device for elemental and in-depth characterisation of materials**
Photograph	
Short description	**Secondary Ion Mass Spectrometer (SIMS)** is a microanalytical technique used to understand the composition (isotopic, elemental, and/or molecular) of a predefined microvolume of solid material, by irradiating it with energetic ions.
Main purpose	SIMS derives compositional information by directing a focused ion beam to the surface of interest. The primary ions induce the emission of atoms and molecules from the solid's surface, a small percentage of which exist in the ionized state. The emitted secondary ions are then collected and passed through a mass spectrometer. SIMS measurements can be performed in three operating modes: - Static SIMS: measurement of mass spectra of the specimen surface - Dynamic SIMS: depth profiling of selected elements or molecules in the sample - Surface imaging: elemental imaging of the sample surface
Technical specifications	The SIMS instrument is a Hidden system with the following equipment: ■ ion gun for low-energy ions of inert and reactive gases (IG20) with energy range of 0.5 – 5 keV (O_2^+ or Ar^+ ions) and ion-beam diameter of 100 μm ■ Caesium ion gun (IG5C) with energy range of 0.5 – 5 keV and ion-beam diameter of 100 μm ■ quadrupole mass analyser (MAXIM HAL7) with mass range: 1- 500 amu and Puls Ion Counting Electron Multiplier detector ■ ionization source for Residual Gas Analyser (RGA) / Sputtered Neutral Mass Spectrometry (SNMS) mode ■ electron gun (FG 500 – SPECS system) –neutralization of surface charging effects
Additional information	http://phy.uniri.hr/en/divisions-and-laboratories/102-en/divisions-and-laboratories/division-of-experimental-and-applied-physics/802-sims.html
Year of manufacture	2014
Source of founding	"Research Infrastructure for Campus-based Laboratories at the University of Rijeka" project financed by ERDF
Contacts	Assoc. Prof. D. Sc. Ivana Jelovica Badovinac (+385 51 584607, ijelov@uniri.hr) Assoc. Prof. D. Sc. Robert Peter (+385 51 584621, rpeter@uniri.hr)

2
EQUIPMENT OF THE LABORATORY FOR THIN FILMS

Instrument	**Atomic Layer Deposition (ALD)**
Laboratory affiliation	**Laboratory for Thin Films**
Equipment category	**Device for thin film deposition**
Photograph	
Short description	**Atomic Layer Deposition (ALD)** is a technique used for a deposition of thin anorganic films, characterized with an excellent precision of thickness of deposited films (in Å-nm range).
Main purpose	ALD can be used to coat wafers, planar objects and porous bulk materials, as well as particles and complex 3D objects. The essence of this technique is to alternately expose surface of the substrate to two different gas compounds (precursors), and this process is repeated in a cyclic manner. The self-limiting aspect of ALD leads to excellent step coverage and conformal deposition, i.e. the deposited film is homogenious and non-porous. Most commonly synthesized materials in our ALD system are semiconductor or isolating thin films such as oxides: ZnO, Al_2O_3, TiO_2, SiO_2 and nitrides: AlN, TiN, Si_3N_4
Technical specifications	Atomic Layer Deposition (ALD) instrument is a Beneq TFS 200 system. ■ substrate temperature range: 25 - 500 °C ■ maximal substrate dimensions (regular chamber): 200 mm in diameter, 3 mm in height ■ maximal substrate dimensions for 3D chamber: 200 mm in diameter, 95 mm in height ■ capacitive coupled plasma system (operates at RF of 13,6 MHz and plasma power up to 300 W) ■ ozone generator (ozone can be used as an oxygen source for ALD synthesis) ■ 4 liquid sources attached to the instrument
Additional information	http://phy.uniri.hr/en/divisions-and-laboratories/50-en/divisions-and-laboratories/823-atomic-layer-dep.html
Year of manufacture	2015
Source of founding	“Research Infrastructure for Campus-based Laboratories at the University of Rijeka” project financed by ERDF
Contacts	Assoc. Prof. D. Sc. Iva Šarić (+385 51 584638, iva.saric@uniri.hr)

3

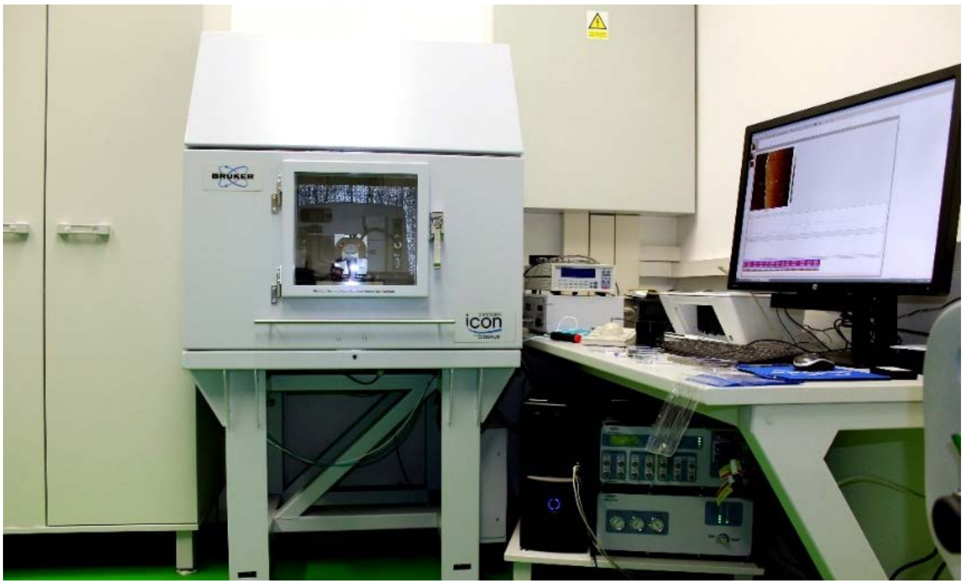
EQUIPMENT OF THE LABORATORY FOR SCANNING ELECTRON MICROSCOPY

Instrument	**Scanning Electron Microscope (SEM)**
Laboratory affiliation:	**Laboratory for Scanning Electron Microscopy**
Equipment category	**Device for characterisation of materials on the nanoscale**
Photograph	
Short description	**Scanning Electron Microscope (SEM)**: a type of electron microscope that permits the observation and characterization of heterogeneous organic and inorganic materials on a nanometre (nm) to micrometre (μm) scale.
Main purpose	The SEM is capable of obtaining 3D-like images of the surfaces of a very wide range of materials. The surface area to be examined or the microvolume to be analysed is irradiated with a finely focused electron beam, which may be swept in a raster across the surface of the specimen to form images or may be static to obtain analyses at one position. Signals produced from the interaction of the electron beam with the sample are in the form of secondary electrons (emitted from the sample) or backscattered electrons (from the impinging electron beam). Signals are obtained from specific emission volumes within the sample and can be used to examine many characteristics of the sample (surface topography, crystallography, chemical composition, etc.).
Technical specifications	The SEM is a JEOL Field Emission Scanning Electron Microscope (JSM-7800F) with maximal resolution of 0.8 nm, accelerating voltage of 0.01 – 30 kV and the magnification range: ×25 - ×1000000. It is equipped with the detectors: ■ Lower secondary electron detector (LED) ■ Upper secondary electron detector (USD) ■ Backscattered electron detector (BED) ■ Scanning Transmission Electron Microscopy (STEM) detector ■ Energy dispersive X-ray spectrometer (EDS) – used for the analysis of the elemental composition of the specimen.
Additional information	http://phy.uniri.hr/en/divisions-and-laboratories/102-en/divisions-and-laboratories/division-of-experimental-and-applied-physics/803-sem.html
Year of manufacture	2014
Source of founding	“Research Infrastructure for Campus-based Laboratories at the University of Rijeka” project financed by ERDF
Contacts	Assoc. Prof. D. Sc. Ivna Kavre Piltaver (+385 51 584618, ivna.kavre@uniri.hr)

Instrument	**Sample preparation instruments**
Laboratory affiliation	**Laboratory for Scanning Electron Microscopy**
Equipment category	**Devices for sample preparation**
Photograph	
Short description	Various precision instruments
Main purpose	Instruments for preparing samples
Technical specifications	■ Precision Etching and Coating System (Gatan PECS II Model 685) – uses dual ion source for the etching of solid samples by low energy Ar^+ ions (energy range 0.1 – 8 keV) and can be used for sample coating with C, Au, Pt/Pd, Cr or Pt. ■ Precision Ion Polishing System (Gatan PIPS II Model 695) - uses dual ion source for the polishing of solid samples by low energy Ar_+ ions (energy range 0.1 – 8 keV), used primarily for the sample preparation for Scanning Transmission Electron Microscopy (STEM) measurements. ■ Critical point dryer (Quorum K 850) – used for dehydrating biological tissue (by replacing water with liquid CO_2) prior to examination in the Scanning Electron Microscope (SEM). ■ Precision diamond wire saw (Well 3242) - uses a stainless steel wire with diamonds embedded into the surface of the wire as a cutting tool; produces smooth, sharp-edged surfaces on variety of materials. ■ Precision saw with diamond discs (Buehler Isomet 1000) – used for cutting various types of materials (metals, composites, laminates, plastics, biomaterials) with minimal deformation, by only using gravity fed force.
Additional information	http://phy.uniri.hr/hr/ustroj/29-hr/ustroj/laboratoriji/794-laboratorij-za-pripremu-sem-uzoraka.html
Year of manufacture	2014
Source of founding	“Research Infrastructure for Campus-based Laboratories at the University of Rijeka” project financed by ERDF
Contacts:	Assoc. Prof. D. Sc. Ivna Kavre Piltaver (+385 51 584618, ivna.kavre@uniri.hr)

4

EQUIPMENT OF THE LABORATORY FOR PRECISION ENGINEERING AND MICRO - AND NANOSYSTEMS TECHNOLOGIES

Instrument	**Bruker Dimension Icon Scanning Probe Microscope (SPM)**
Laboratory affiliation	**Laboratory for precision engineering and micro- and nanosystems technologies**
Equipment category	**Device for characterization of materials and surfaces on atomic scale**
Photograph	
Short description	Scanning probe microscope encompassing the functionality of an Atomic Force Microscope (AFM) and a Scanning Tunnelling Microscope (STM) with control software
Main purpose	The SPM enables measurements of elasticity modulus, adhesion, lateral force (LFM), spectroscopy and force modulation, electrochemical analysis, electric field and magnetic forces, surface potential, piezoelectric forces; enables also nanolithography, … Option to measure in liquid for biotechnical applications and measurements with heating/cooling of the samples
Technical specifications	■ Supports contact and tapping mode measurements, which limits the contact forces to < 200 pN, i.e. a value far lower than the tapping forces of other devices – PeakForce tapping ■ Imaging of measured data on 5’120 x 5’120 pixels. ■ Scan range up to 90 µm x 90 µm, Z range 10 µm ■ Samples fixed to the support via a 210 mm vacuum chuck can be up to few mm in size and 15 mm thick ■ Bidirectional positioning repeatability 3 µm on 180 x 150 mm inspectable area ■ Includes heat (creep < 200 pm/min) and vibration isolation (1” Si damping cushion + compressed air → < 30 pm RMS), microscope and 5 Mpx CCD camera, … ■ CE certified
Additional information	https://www.bruker.com/products/
Year of manufacture	2014
Source of founding	“Research Infrastructure for Campus-based Laboratories at the University of Rijeka” project financed by ERDF
Contacts	Prof. D. Sc. Saša Zelenika (+ 385 51 584 633, sasa.zelenika@uniri.hr) D. Sc. Ervin Kamenar (+ 385 51 584 766 , ekamenar@uniri.hr)

Instrument	**Keysight G200 Nanoindenter**
Laboratory affiliation	**Laboratory for precision engineering and micro- and nanosystems technologies**
Equipment category	**Device for measurement of materials' properties on micro- and nano-scale**
Photograph	 
Short description	Nanoindenter with data analysis software
Main purpose	Accurate determination of elasticity modulus and hardness according to ISO 14577., i.e., quantitative measurement of mechanical properties of small volumes of material
Technical specifications	■ 4 samples in a 100 x 100 mm sample holder with a scanning resolution of 0.1 µm and 1 µm accuracy ■ Electromagnetic actuation (voice coil principle), i.e. load generation: max 0.5 N with a 50 nN resolution; additional built-in high-load system with 0.1 mN … 10 N load range ■ Loading system stiffness (guided by leaf springs): 5.10^6 N/m ■ Capacitive displacement measurement: resolution < 0.01 nm for >500 µm indentation depth ■ Total indenter travel: 1.5 mm ■ Obtainable straightness in a 100 mm range is within 10 nm ■ Enables LFM with a ≤ 2 mN resolution and max lateral force ≥ 250 mN ■ Berkovich, cube corner, conical, spherical and Vickers tips with calibration and conformity certificate of each tip ■ System for sample visualization (10x and 40x zoom), and microscope with CCD camera ■ Thermally as well as dynamically (and acoustically) isolated
Additional information	http://www.keysight.com/en/pc-1678689/nanoindenters?cc=US&lc=eng
Year of manufacture	2014
Source of founding	"Research Infrastructure for Campus-based Laboratories at the University of Rijeka" project financed by ERDF
Contacts	Prof. D. Sc. Saša Zelenika (+ 385 51 584 633, sasa.zelenika@uniri.hr) D. Sc. Ervin Kamenar (+ 385 51 584 766 , ekamenar@uniri.hr)

Instrument	**Stratasys Fortus 250 mc 3D printer**
Laboratory affiliation	**Laboratory for precision engineering and micro- and nanosystems technologies**
Equipment category	**Device for additive manufacturing via 3D printing**
Photograph	 
Short description	3D printer with control software
Main purpose	Create a free-shape three-dimensional object in which layers of material are deposited under computer control
Technical specifications	■ FDM (Fused Deposition Modelling) technology (heating and extrusion of thermoplastics) ■ Material: ABSplus (acrylonitrile butadiene styrene). ■ For models with dimension of up to 254 x 254 x 305 mm ■ 178 μm layer thickness ■ Positioning accuracy of 240 μm ■ 2 heads for building and support material ■ Import of STL (Standard Tessellation Language) 3D models from CAD environment ■ SW for printing process optimization (including support structure optimization)
Additional information	https://proto3000.com/fortus-250mc.php
Year of manufacture	2014
Source of founding	"Research Infrastructure for Campus-based Laboratories at the University of Rijeka" project financed by ERDF
Contacts	Prof. D. Sc. Saša Zelenika (+ 385 51 584 633, sasa.zelenika@uniri.hr) D. Sc. Ervin Kamenar (+ 385 51 584 766 , ekamenar@uniri.hr)

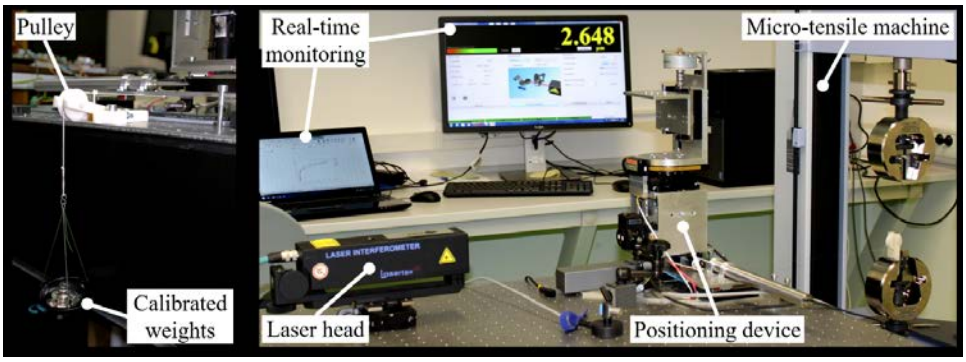
Instrument	**DAVID SLS-2 3D Scanner**
Laboratory affiliation	**Laboratory for precision engineering and micro- and nanosystems technologies**
Equipment category	**3D non-contact scanner**
Photograph	
Short description	3D scanner comprising a projector, the camera, calibration panels and a rotating table – with control software
Main purpose	Capturing real world data and converting it into 3D models Basis for reverse engineering (and, in combination with 3D printers, of rapid prototyping)
Technical specifications	■ The distance and the angle of the camera with respect to the projector are known, i.e. the distortion of the reflected light pattern (fringes) depends on object's geometry ■ 500 mm scanning area ■ Resolution/accuracy: 1‰ of the object size ■ Includes SW environment ■ Mobile with tripod ■ Enables exporting of data to formats compatible with standard CAD SW (e.g. STL)
Additional information	http://www.david-3d.com/en/support/david4/sls-overview
Year of manufacture	2014
Source of founding	"Research Infrastructure for Campus-based Laboratories at the University of Rijeka" project financed by ERDF
Contacts	Prof. D. Sc. Saša Zelenika (+ 385 51 584 633, sasa.zelenika@uniri.hr) D. Sc. Ervin Kamenar (+ 385 51 584 766 , ekamenar@uniri.hr)

Instrument	**HAAS Office OM-2A milling machine**
Laboratory affiliation	**Laboratory for precision engineering and micro- and nanosystems technologies**
Equipment category	**Machine tools for sample preparation**
Photograph	
Short description	CNC milling machine characterized by small dimensions as well as outstanding performances and exceptional benefits for the end users
Main purpose	Transforms a stock piece of material into a finished product by means of a controlled material removal process
Technical specifications	■ Dimensions within an 1.7 x 0.84 x 1.9 m envelope ■ Enables 5-axes machining with up to 20 automatically interchangeable tools ■ Machining volume 305 x 254 x 305 mm ■ 1 μm displacement resolution ■ Spindle velocity of up to 30'000 rpm ■ 3.7 kW power ■ Includes user-friendly interface and a HAAS/Fanuc control unit
Additional information	https://www.techspex.com/machining-centers/haas-automation(2501)/4489
Year of manufacture	2014
Source of founding	"Research Infrastructure for Campus-based Laboratories at the University of Rijeka" project financed by ERDF
Contacts	Prof. D. Sc. Saša Zelenika (+ 385 51 584 633, sasa.zelenika@uniri.hr) D. Sc. Ervin Kamenar (+ 385 51 584 766 , ekamenar@uniri.hr)

Instrument	**HAAS Office OL-1 lathe**
Laboratory affiliation	**Laboratory for precision engineering and micro- and nanosystems technologies**
Equipment category	**Machine tools for sample preparation**
Photograph	
Short description	CNC lathe characterized by small dimensions as well as outstanding performances and exceptional benefits for the end users
Main purpose	Transforms a stock piece of material into a finished product by means of a controlled material removal process
Technical specifications	■ Dimensions within an 1.3 x 0.84 x 1.98 m envelope ■ 2-axes machining with 12 tools ■ Turning diameter of up to 125 mm ■ 1 µm displacement resolution ■ Spindle velocity of up to 6’000 rpm ■ 5.6 kW power ■ Includes user-friendly interface and a HAAS/Fanuc control unit
Additional information	http://int.haascnc.com/lathe_intro.asp?intLanguageCode=1033
Year of manufacture	2014
Source of founding	“Research Infrastructure for Campus-based Laboratories at the University of Rijeka” project financed by ERDF
Contacts	Prof. D. Sc. Saša Zelenika (+ 385 51 584 633, sasa.zelenika@uniri.hr) D. Sc. Ervin Kamenar (+ 385 51 584 766 , ekamenar@uniri.hr)

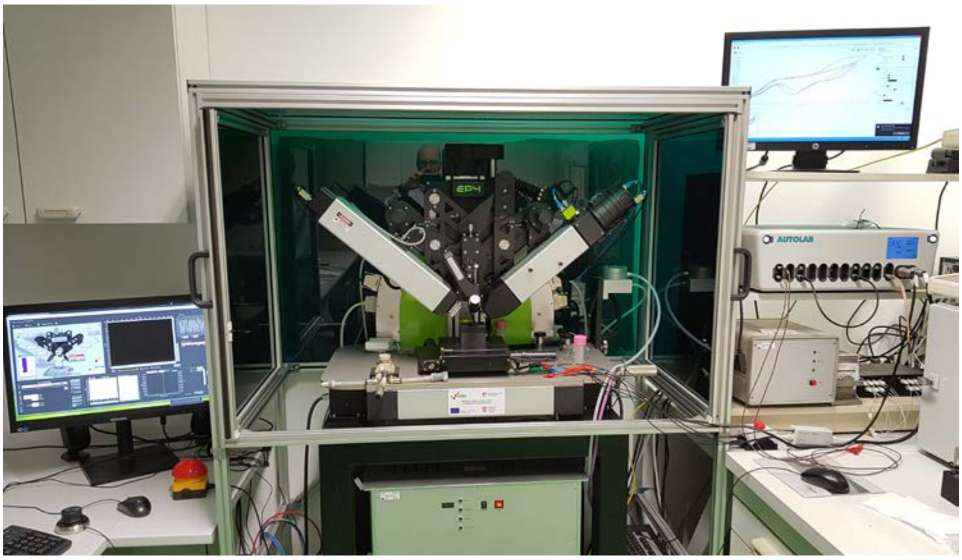
Instrument	**Ultrasonic cleaner SONOREX Technik RM40**
Laboratory affiliation	**Laboratory for precision engineering and micro- and nanosystems technologies**
Equipment category	**Ultrasonic cleaning of samples for (ultra-high) vacuum**
Photograph	
Short description	Ultrasonic cleaning device with multiple components
Main purpose	Equipment for ultrasonic cleaning of samples for (ultra-high) vacuum
Technical specifications	■ 1. heated (up to 70 °C) prewash with oil separation ■ 2. ultrasonic cleansing (10 PZT inverters, 40 kHz, 500 W continuous and 2 kW peak power) in a 45 l heated stainless steel bath with a “soft” (pH 9.9) detergent and with filtering of media (particles’ separation) ■ 3. 2 baths for rinsing in demineralized water with heating (1.2 kW, 30 … 80 °C) ■ 4. drying with hot air (up to 300 °C)
Additional information	http://monmouthscientific.co.uk/image/data/Ultrasonic/SonorexTechnikTechSheetPricelist2012.pdf
Year of manufacture	2014
Source of founding	“Research Infrastructure for Campus-based Laboratories at the University of Rijeka” project financed by ERDF
Contacts	Prof. D. Sc. Saša Zelenika (+ 385 51 584 633, sasa.zelenika@uniri.hr) D. Sc. Ervin Kamenar (+ 385 51 584 766 , ekamenar@uniri.hr)

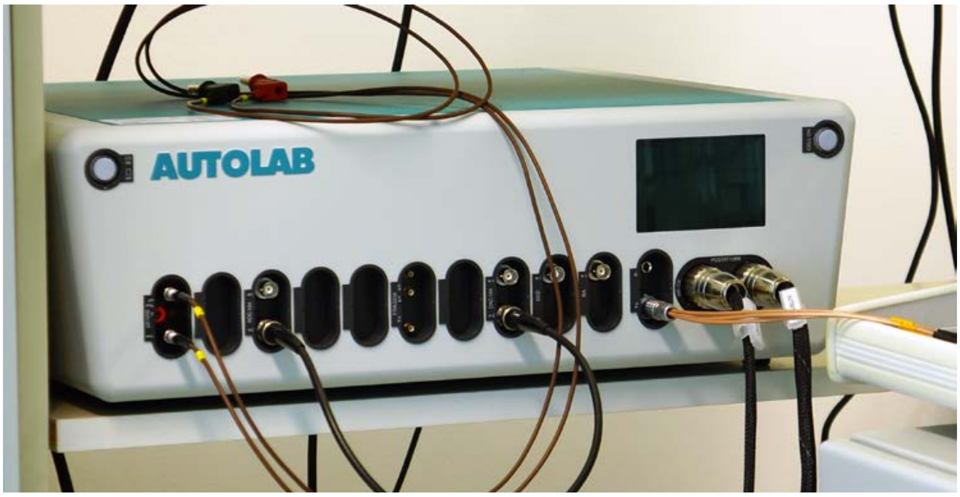
Instrument	**Shimadzu Autograph AGS-X**
Laboratory affiliation	**Laboratory for precision engineering and micro- and nanosystems technologies**
Equipment category	**Measurement of mechanical properties of materials**
Photograph	
Short description	Micro-tensile machine
Main purpose	Tensile machine for accurate measurement of mechanical properties (elasticity modulus, strength, tensile tests, compression tests, bending tests, …) of materials with superior performances and practical testing solutions
Technical specifications	■ Loading range up to 5 kN ■ Loading resolution 2 mN ■ Displacement resolution 10 μm ■ Characterisation of mechanical properties of metals, ceramics, polymers, rubber and composites ■ Offers real-time auto tuning of control parameters, based on measured test force and strain data ■ High-speed sampling of 1 ms ensures no missed strength changes
Additional information	https://www.ssi.shimadzu.com/products/literature/Testing/C224-E057.pdf
Year of manufacture	2014
Source of founding	"Research Infrastructure for Campus-based Laboratories at the University of Rijeka" project financed by ERDF
Contacts	Prof. D. Sc. Saša Zelenika (+ 385 51 584 633, sasa.zelenika@uniri.hr) D. Sc. Ervin Kamenar (+ 385 51 584 766, ekamenar@uniri.hr)

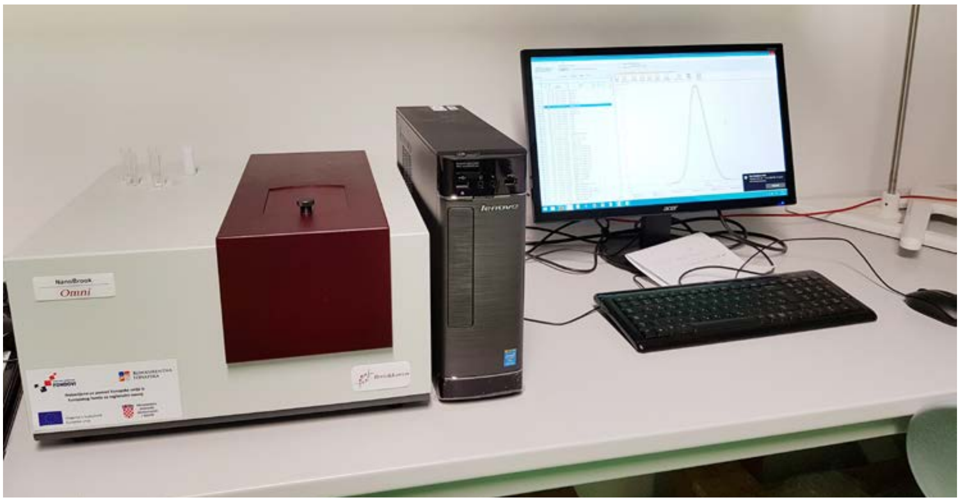
Instrument	**Electro-opto-mechanical components**
Laboratory affiliation	**Laboratory for precision engineering and micro- and nanosystems technologies**
Equipment category	**Tools for sample preparation and characterisation**
Photograph	
Short description	Electro-opto-mechanical tools and devices
Main purpose	Tools for sampling, preparation and characterisation of materials
Technical specifications	■ Newport optical table RS 2000™ with 4 adjustable legs (passively damped working surface, metric) ■ Pillar drilling machine BOSCH PBD 400 (digital display, d_{max} = 13 mm, adjustable rotation speed) ■ Oscilloscope Keysight (bandwidth 100 MHz, 4 analog + 8 digital channels, 2 GS/s, WVGA color display) ■ Multimeter Fluke x 4 (measurement of I, U, R, C, f, temperature) ■ UV Exposure Box for Printed Circuit Boards UV (4 x 15 W, 350 x 250 mm) ■ Soldering station Weller PUWAD101 (80 W, temp. span 150-450 °C, 1 output) ■ Laboratory power supply - Welleman (digital, 3 outputs, regulation of voltage 0-30 V and regulation of current 0-3 A) ■ Battery drill/screwdriver BOSCH (M = 30 Nm, 18 V Li-Ion, n_{max} = 1250 min^{-1}) ■ Micro drill/grinding machine Welleman/Proxxon (125 W, n = 10’000 – 30’000 min^{-1}) ■ Electric hand drilling machine FEIN BOP6 (1500 W, drilling diameter up to 14 mm, rotational speed up to 4000 rpm) ■ Laser distance measurement device (for distances up to 10 m with mm resolution) ■ Laboratory calibrated weights (1 mg - 0,5 kg, calibration standard – class F1) ■ Digital micrometers SCHUT (0-150 mm, resolution 1 μm) ■ Various hand tools
Additional information	/
Year of manufacture	2014
Source of founding	“Research Infrastructure for Campus-based Laboratories at the University of Rijeka” project financed by ERDF
Contacts	Prof. D. Sc. Saša Zelenika (+ 385 51 584 633, sasa.zelenika@uniri.hr) D. Sc. Ervin Kamenar (+ 385 51 584 766 , ekamenar@uniri.hr)

5

EQUIPMENT OF THE LABORATORY FOR COLLOIDS, POLYELECTROLYTES AND INTERFACES

Instrument	**Spectroscopic imaging ellipsometer Accurion EP4**
Laboratory affiliation	**Laboratory for Colloids, Polyelectrolytes and Interfaces**
Equipment category	**Thin film characterization**
Photograph	
Short description	Spectroscopic ellipsometry is a well-known non-destructive optical method for determining the thickness and opto-electronic properties of thin films. Imaging ellipsometry combines the power of ellipsometry with microscopy and overcomes the limits of classical ellipsometers
Main purpose	The modularity of the Accurion EP4 Imaging Ellipsometer offers many advantages: Spectroscopic ellipsometry with highest lateral resolution (2μm) – mapping the dielectric function; 3D thickness maps. The EP4 model software enables fitting the thicknesses and iso- or anisotropic dielectric functions for stacked layers of different optical materials. The solid-liquid and electrochemical cells enable measurements in contact with liquid medium, and under electrochemical bias (in combination with potentiostat Autolab PGTSAT 128 N). Brewster angle microscopy - a high contrast image of liquid surfaces without use of dies. Surface plasmon resonance measurements with lateral resolution of 2μm. Typical applications are in the triangle between physics and biophysics, material chemistry and nanotechnology.
Technical specifications	■ AOI: 45-70 deg. ■ wavelength range for SE: 380-1700 nm ■ measurement method: nulling ellipsometry ■ optical magnification: 5x, 10x, 20x
Additional information	https://www.accurion.com/thin-film-characterization-imaging-ellipsometry/nanofilm_ep4
Year of manufacture	2014
Source of founding	“Research Infrastructure for Campus-based Laboratories at the University of Rijeka” project financed by ERDF.
Contacts	Assoc. Prof. D. Sc. Duško Čakara (+385 51 584555, dcakara@uniri.hr)

Instrument	**Autolab PGSTAT128 potentiostat for electrochemical measurements**
Laboratory affiliation	**Laboratory for Colloids, Polyelectrolytes and Interfaces**
Equipment category	**Electrochemical measurements**
Photograph	
Short description	Autolab PGSTAT 128N is a state-of-the-art potentiostat offering measurements with three- or four-electrode electrochemical cells. In combination with the NOVA software, it offers a wide range of methods frequently used in preparative and analytical electrochemistry, including chronoamperometry, chronopotentiometry, voltammetry with a range of different potential sweep modes. The additional bipotentiostat module offers the potential sweep at 2 different electrode terminals, while the FRA32 module offers measurements of electrochemical impedance spectroscopy (EIS)
Main purpose	Electrochemical measurements: cyclic voltammetry, electrochemical impedance spectroscopy, chronoamperometry, chronopotentiometry
Technical specifications	■ Electrode connections: 2, 3 and 4 ■ Potential range: +/- 10 V ■ Maximum current: +/- 800 mA ■ Current ranges: 1 A to 10 nA ■ Current resolution: 0.0003 % (of current range) ■ Input impedance: > 1 TOhm ■ Potentiostat bandwidth: 500 kHz ■ FRA32 M: frequency range 10 μHz - 1 MHz; ■ Frequency resolution: 0.003 % ■ Input range: 10 V ■ Signal types: 1 sine, 5 sine, 15 sine ■ AC amplitude: 0.2 mV to 0.35 V rms inpotentiostatic mode ■ Data presentation Nyquist, Bode, Admittance, Dielectric, Mott-Schottky… ■ Graphical equivalent circuit modelling and fitting in NOVA
Additional information	http://www.metrohm-autolab.com/Products/Echem/NSeriesFolder/PGSTAT128N
Year of manufacture	2014
Source of founding	"Research Infrastructure for Campus-based Laboratories at the University of Rijeka" project financed by ERDF
Contacts	Assoc. Prof. D. Sc. Duško Čakara (+385 51 584555, dcakara@uniri.hr)

Instrument	**Brookhaven NanoBrook OMNI zetasizer**
Laboratory affiliation	**Laboratory for Colloids, Polyelectrolytes and Interfaces**
Equipment category	**Nanoparticle sizing and electrophoretic mobility measurement**
Photograph	
Short description	The particle size distribution measurement is based on principles of Dynamic Light Scattering (DLS), while Doppler velocimetry (electrophoretic light scattering, ELS) is used for zeta potential measurement. The instrument also includes Phase Analysis Light Scattering (PALS) measurements for samples with low mobilities, while the available three scattering angles (90°, forward and backscattering) allow optimal experimental conditions for sizing of small particles and polyelectrolytes (< 50 nm) or aggregated turbid samples.
Main purpose	The NanoBrook Omni particle size and zeta potential analyser is an instrument for size and electrophoretic mobility measurements in suspensions of nanoparticles and polyelectrolytes, including proteins
Technical specifications	■ Particle size range: < 0.3 nm to 10 µm ■ Three measurement angles: 15°, 90°, and 173° ■ Dynamic light scattering at 173° and 90° ■ Sizing: Globular proteins, nanoparticles, and small polymers as well as most colloidal-sized materials in any non-absorbing liquid ■ Zeta Potential: Proteins, nanoparticle, polymer and colloidal-sized materials, suspended in any non-absorbing liquid, with relative permittivity (dielectric constant) > 1.5 and viscosity < 30 cP ■ Mobility range: 10-11 to 10-7 m2 /V*s ■ Zeta potential range: 220 mS/cm, covering saline and PBS solutions for proteins, sample dependent ■ Concentration range: Sizing: 0.1 ppm to 50 mg/mL, depending on refractive index and concentration ■ Zeta potential: 40% v/v, sample dependent ■ Laser: 35 mW red diode laser, nominal 640 nm wavelength
Additional information	https://www.brookhaveninstruments.com/nanobrook-omni
Year of manufacture	2014
Source of founding	“Research Infrastructure for Campus-based Laboratories at the University of Rijeka” project financed by ERDF
Contacts	Assoc. Prof. D. Sc. Duško Čakara (+385 51 584555, dcakara@uniri.hr)

6

EQUIPMENT OF THE LABORATORY FOR MACROMOLECULAR RESEARCH

Instrument	**Fourier Transform Infrared (FTIR) Spectrometer with Universal Attenuated Total Reflexion (UATR)**
Laboratory affiliation	**Laboratory for Macromolecular Research**
Equipment category	**Infrared spectrometer**
Photograph	
Short description	Fourier Transform Infrared Spectrometer
Main purpose	**Fourier Transform Infrared (FTIR) Spectroscopy** is a technique used to obtain the information about molecular structure on the base of absorption or emission infrared spectra. Particularly it is used in organic chemistry for identification of functional groups. It is often applied to analyze structural parameters of various materials, but also in biomedical research as a powerful method for the rapid differentiation and identification of microorganisms, contributing to clinical medicine. Particularly, in our laboratory this technique is mostly applied for monitoring structural parameters of polymers and polymer composits and their changes caused by ageing or high energy radiation.
Technical specifications	■ Spectral range: 8,300 – 350 cm-1 ■ Spectral resolution 0,4 cm-1 ■ Wavenumber Precision 0.008 cm-1 at 2,000 cm-1 ■ Wavenumber Accuracy 0.02 cm-1 at 2,000 cm-1
Additional information	http://www.perkinelmer.com/product/frontier-mir-spectrum-10-std-l1280002
Year of manufacture	2014
Source of founding	“Research Infrastructure for Campus-based Laboratories at the University of Rijeka” project financed by ERDF
Contacts	Prof. D. Sc. Srećko Valić (+ 385 51 651 135, svalic@uniri.hr) Assoc. Prof. D. Sc. Damir Klepac (+ 385 51 651 187, damir.klepac@uniri.hr)

Instrument	**Thermogravimetric Analyzer with Mass Spectrometer**
Laboratory affiliation	**Laboratory for Macromolecular Research**
Equipment category	**Mass spectrometer**
Photograph	
Short description	Thermogravimetric analyser
Main purpose	**Thermogravimetric analyser** continuously and precisely measures mass while the temperature of a sample is changed over time. Mass, temperature, and time in thermogravimetric analysis are considered base measurements while many additional measures may be derived from these three base measurements. The thermogravimetric data collected from a thermal reaction is compiled into a plot of mass or percentage of initial mass on the y axis versus either temperature or time on the x-axis. A TGA can be used for materials characterization through analysis of characteristic decomposition patterns. Particularly, when coupled with mass spectrometry it is a powerful tool in the determination of chemical composition. It is an especially useful technique for the study of polymeric materials, including thermoplastics, thermosets, elastomers, composites, plastic films, fibres, coatings, paints, and fuels. Therefore this technique is very useful in the field of environmental science and food, pharmaceutical and petrochemical industry.
Technical specifications	■ Temperature range from room temperature to 1000 °C ■ Precision from ± 1 °C, accuracy from ± 0.4 °C ■ Balance sensitivity from 10-6 to 10-7 (from 0.1 to 1 μg/g) ■ Balance precision 0.001%, Balance accuracy ± 0.02% ■ All accessories needed for attaching MS to TGA. ■ Set of appropriate TGA pans (1000 pcs)
Additional information	http://www.perkinelmer.com/category/thermogravimetry-tga-instruments
Year of manufacture	2014
Source of founding	“Research Infrastructure for Campus-based Laboratories at the University of Rijeka” project financed by ERDF
Contacts	Prof. D. Sc. Srećko Valić (+ 385 51 651 135, svalic@uniri.hr) Assoc. Prof. D. Sc. Damir Klepac (+ 385 51 651 187, damir.klepac@uniri.hr)

Instrument	**Gas Permeation Chromatograph (GPC)**
Laboratory affiliation	**Laboratory for Macromolecular Research**
Equipment category	**GPC**
Photograph	
Short description	Gas permeation Chromatograph (GPC)
Main purpose	**Gel permeation chromatography (GPC)**, also known as size exclusion chromatography (SEC) separates analytes on the basis of the molecular size in solution. The technique is often used for the analysis of various macromolecular systems, particlularly natural and sinthetic polymers. Basically, this technique give a possibility to measure molecular masses of such compounds, based on their hydrodynamic volume in solution. Additionally, polydispersity index (PDI) or molecular mass distribution (MMD) can be also determined by this technique. These data are very important for mechanical properties of materials, related to their practical application
Technical specifications	■ RI and Light Scattering detectors ■ Column porosity 3, 5, 10 μm ■ Column capacity: 5 x 30 cm ■ Max flow rate: (analysis) 2.0 mL/min (solvent exchange) 0.3 mL/min ■ Pump flow rate: 0.01 to 10.00 mL/min, programmable soft start
Additional information	http://www.pss-polymer.com/products/lc-instruments-and-detectors/seccurity2-gpc-system/
Year of manufacture	2014
Source of founding	"Research Infrastructure for Campus-based Laboratories at the University of Rijeka" project financed by ERDF
Contacts	Prof. D. Sc. Srećko Valić (+ 385 51 651 135, svalic@uniri.hr) Assoc. Prof. D. Sc. Damir Klepac (+ 385 51 651 187, damir.klepac@uniri.hr)

Instrument	**Dynamic Mechanical Analyzer (DMA)**
Laboratory affiliation	**Laboratory for Macromolecular Research**
Equipment category	**DMA**
Photograph	
Short description	Dynamic mechanical analyser
Main purpose	**Dynamic mechanical analysis (DMA)**, also known as dynamic mechanical spectroscopy, is a technique used to study and characterize various materials. It is often applied for studying the viscoelastic behaviour of polymers. A sinusoidal stress is applied and the strain in the material is measured, allowing one to determine the complex modulus. The temperature of the sample or the frequency of the stress are often varied, leading to variations in the complex modulus; this approach can be used to locate the glass transition temperature of the material, as well as to identify transitions corresponding to other molecular motions.
Technical specifications	■ Temperature range from -190 °C to 600 °C ■ Frequency range from 0 to 300 Hz ■ Frequency resolution 0.001 Hz ■ Dynamic Displacement from 0 to ±1000 μm. ■ Modulus resolution 0.0001 Pa; modulus range ~103 to 1016 Pa ■ Tan Delta resolution 0.00001 ■ Maximum Sample Size: 52.5 mm x 12.8 mm x 8.0 mm ■ TMA Mode: ■ Measurement range ±1000 μm; ■ Sample size up to 10 mm ■ Geometry: tension and compression ■ Sensitivity: 10 nM ■ Force load min/max 0.002 N / ±10 N
Additional information	http://www.perkinelmer.com/product/dma-8000-analyzer-qtz-window-ssti-clamp-n5330101
Year of manufacture	2015
Source of founding	“Research Infrastructure for Campus-based Laboratories at the University of Rijeka” project financed by ERDF
Contacts	Prof. D. Sc. Srećko Valić (+ 385 51 651 135, svalic@uniri.hr) Assoc. Prof. D. Sc. Damir Klepac (+ 385 51 651 187, damir.klepac@uniri.hr)

Instrument	**Gas Adsorption Porosimeter**
Laboratory affiliation	**Laboratory for Macromolecular Research**
Equipment category	**Porosimeter**
Photograph	
Short description	Gas Adsorption Porosimeter ASAP 2020
Main purpose	**Gas Adsorption Porosimeter** is an instrument which gives the possibility to characterize the surface as well as the free volume in various types of materials (polymers, ceramics etc.). The technique is based on the gas absorption, and the results indicate the size and size distribution of free volume holes inside the investigated sample. This powerful technique can be very useful in the study and production of pharmaceuticals, catalysts, adsorbents, materials for separation technologies, pigments, cosmetics and construction materials. Additionally, it can be applied for geological investigations.as well as to identify transitions corresponding to other molecular motions.
Technical specifications	■ Gas temperature measurement resolution: 0.01 °C ■ Two vacuum independent degassing stations with two temperature zones up to 450 °C ■ Specific surface area:~ 0.01 m^2/g and above (N_2/77K); ~0.0005 m^2/g and above (Kr/77K) ■ Specific pore volume: from 0.0001 cc/g ■ Pore size range: 0.32-500 nm in pore diameter ■ Maximum inlet pressure ~150 kPa ■ Pressure measurement accuracy better than 0.25% ■ Temperature stability: ±0.1°C ■ Coolant system: Liquid nitrogen and liquid argon with automatic level control. Automatic Dewar raising and lowering ■ Degasser unit accuracy: ± 1 % of full scale temperature.
Additional information	http://www.micromeritics.com/Product-Showcase/ASAP-2020-Plus-Chemisorption.aspx
Year of manufacture	2015
Source of founding	“Research Infrastructure for Campus-based Laboratories at the University of Rijeka” project financed by ERDF
Contacts	Prof. D. Sc. Srećko Valić (+ 385 51 651 135, svalic@uniri.hr) Assoc. Prof. D. Sc. Damir Klepac (+ 385 51 651 187, damir.klepac@uniri.hr)

Instrument	**Testing Machine**
Laboratory affiliation	**Laboratory for Macromolecular Research**
Equipment category	**Characterisation of mechanical properties**
Photograph	
Short description	Testing machine
Main purpose	**Testing machine** allows to measure mechanical properties of materials. In our laboratory it is predominantly used for measuring stress-strain curves of various elastomers and their composites, in one or multiple cycles under the control of frequency and amplitude. We possess standard matrices of various shapes for the sample preparation.
Technical specifications	■ Testing load range: from 0.5 to 5 kN ■ Height: 1000 mm ■ Accuracy of the set speed: 0.05 % of set speed ■ Repetition accuracy: ±2μm
Additional information	http://www.ssi.shimadzu.com/products/product.cfm?product=eztest
Year of manufacture	2015
Source of founding	"Research Infrastructure for Campus-based Laboratories at the University of Rijeka" project financed by ERDF
Contacts	Prof. D. Sc. Srećko Valić (+ 385 51 651 135, svalic@uniri.hr) Assoc. Prof. D. Sc. Damir Klepac (+ 385 51 651 187, damir.klepac@uniri.hr)

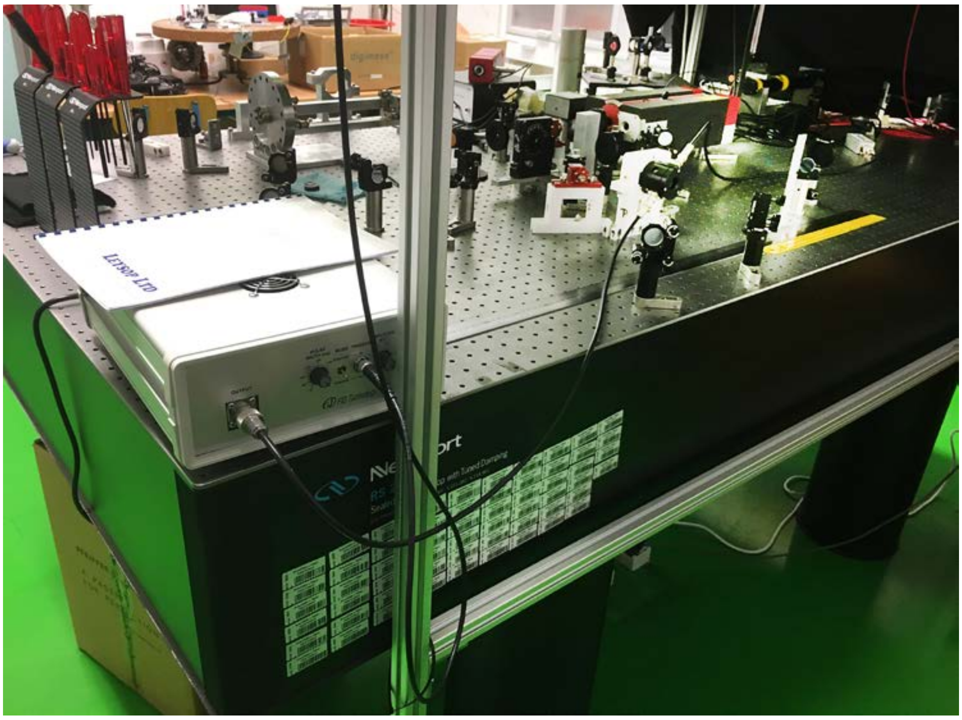
7

EQUIPMENT OF THE LABORATORY FOR QUANTUM AND NONLINEAR OPTICS

Instrument	**Light source**
Laboratory affiliation	**Laboratory for quantum and nonlinear optics**
Equipment category	**Light source**
Photograph	
Short description	Ultra-Narrow Linewidth CW DPSS Green Laser is based on a Non-Planar Ring Oscillator (NPRO) configuration. The output from Nd:YAG NPRO is frequency doubled in an efficient periodically poled crystal. Output power up to 100 mW is available at green wavelength. In addition, the depleted 1064 nm beam is also available, with output power up to 1.5 W. Linewidth, frequency tuning, frequency stability and noise of both green and IR beams are determined by the unique properties of NPRO and low noise electronics. The Noise Eater circuitry eliminates residual pump diode and relaxation oscillation noise at frequencies below 1 MHz.
Main purpose	Light source for precision measurements in metrology and quantum optics.
Technical specifications	■ Laser power 20 mW @532 nm and 1000 mW @1064nm ■ Laser control electronics – analog, stand alone ■ Continuous wave ■ TEM00 spatial modelling Thermal and PZT tuning ■ single frequency ■ coherence length > 1 km ■ Spectral linewidth ~ 1 kHz
Additional information	https://www.coherent.com
Year of manufacture	2013
Source of founding	“Research Infrastructure for Campus-based Laboratories at the University of Rijeka” project financed by ERDF
Contacts	Assoc. Prof. D. Sc. Marin Karuza (+385 51 584 611, mkaruza@phy.uniri.hr)

Instrument	**Oscilloscope**
Laboratory affiliation	**Laboratory for quantum and nonlinear optics**
Equipment category	**Measurement device**
Photograph	
Short description	Oscilloscopes are used to observe the change of an electrical signal over time, such that voltage and time describe a shape which is continuously graphed against a calibrated scale. The observed waveform can be analysed for such properties as amplitude, frequency, rise time, time interval, distortion and others. Modern digital instruments may calculate and display these properties directly. Originally, calculation of these values required manually measuring the waveform against the scales built into the screen of the instrument.
Main purpose	Measure and display of electrical signals as waveforms on the screen.
Technical specifications	■ 4 input channels ■ analog bandwidth 1 GHZ ■ rise time 350 ps ■ Input coupling AC, DC, GND ■ input impedance 1 MΩ, 50 Ω ■ input sensitivity 1mV/div t0 10V/div (1 V/div @50Ω) ■ vertical resolution 8 bits
Additional information	https://www.tektronix.com
Year of manufacture	2013
Source of founding	“Research Infrastructure for Campus-based Laboratories at the University of Rijeka” project financed by ERDF
Contacts	Assoc. Prof. D. Sc. Marin Karuza (+385 51 584 611, mkaruza@phy.uniri.hr)

Instrument	**Analog to digital and digital to analog converters**
Laboratory affiliation	**Laboratory for quantum and nonlinear optics**
Equipment category	**Data acquisition and signal generation**
Photograph	
Short description	Data acquisition (DAQ) is the process of measuring an electrical or physical phenomenon such as voltage, current, temperature, pressure, or sound with a computer. A DAQ system consists of sensors, DAQ measurement hardware, and a computer with programmable software. Compared to traditional measurement systems, PC-based DAQ systems exploit the processing power, productivity, display, and connectivity capabilities of industry-standard computers providing a more powerful, flexible, and cost-effective measurement solution.
Main purpose	Measure and generate electrical signals and process, visualize and store them on a computer
Technical specifications	■ Accepts 3U PXI Express, CompactPCI Express, and hybrid slot compatible PXI-1/CompactPCI (PICMG EXP.0 R1.0) modules ■ 5 peripheral slots in a rugged, compact chassis with universal AC input, and automatic voltage/frequency ranging ■ Integrated MXI-Express controller ■ rise time 1.4 ns, bandwidth 250 MHz, ENOB up to 7.6 ■ real time sample rate 2.5 GS/s, RIS up to 50 GS/s ■ jitter < 200 fs, amplitude resolution <0.1 dB ■ amplitude settling time 0.05 dB of final value < 500 ms ■ VSWR < 1.8:1, typical, output impedance 50 Ω
Additional information	https://www.ni.com
Year of manufacture	2013
Source of founding	“Research Infrastructure for Campus-based Laboratories at the University of Rijeka” project financed by ERDF
Contacts	Assoc. Prof. D. Sc. Marin Karuza (+385 51 584 611, mkaruza@phy.uniri.hr)

Instrument	**Optical table with optical and optomechanical elements**
Laboratory affiliation	**Laboratory for quantum and nonlinear optics**
Equipment category	**Parts and devices for high sensitivity measurements**
Photograph	
Short description	Optical tables provide damping for applications such as biomedical imaging, scanning microscopy, spectroscopy, interferometry, electrophysiology, precision measurements and more. The optical and optomechanical elements provide the capability to design and construct custom oriented measurement setups. Spherical lenses are used for beam focusing and beam expansion
Main purpose	Support and setup precision experiments and measurements.
Technical specifications	■ Two precision tunable dampers concentrate damping where it's needed ■ Trussed honeycomb core improves table stiffness ■ Excellent vibration immunity for a passive table top ■ Triple core interface increases point loading capability ■ Mounting holes individually sealed with conical polymeric cup ■ 100-TPI adjusters ■ Hardened carbide pads ■ N-BK7 or UV grade fused silica substrates ■ Uncoated or AR coated optics ■ lens range f = -50 mm to 1500 mm
Additional information	https://www.newport.com
Year of manufacture	2014
Source of founding	"Research Infrastructure for Campus-based Laboratories at the University of Rijeka" project financed by ERDF
Contacts	Assoc. Prof. D. Sc. Marin Karuza (+385 51 584 611, mkaruza@phy.uniri.hr)

8

EQUIPMENT OF THE LABORATORY FOR SYNTHESIS OF FUNCTIONAL MATERIALS

Instrument	**UV system for polymerization (INTELLI-RAY 600)**
Laboratory affiliation	**Laboratory for Synthesis of Functional Materials**
Equipment category	**Polymerization system**
Photograph	
Short description	Microprocessor
Main purpose	The INTELLIRAY is a compact microprocessor controlled UV flood curing system or UV polymerization of monomers in the presence of initiator sensitive on light.
Technical specifications	■ 600W UVA enhanced arc lamp ■ X Microprocessor control of time & intensity vIntegrated exposure shutter ■ 175 mW/cm^2 Intensity ■ 8” x 6” curing area ■ Shielded benchtop curing chamber
Additional information	https://www.brookhaveninstruments.com/nanobrook-omni
Year of manufacture	2014
Source of founding	“Research Infrastructure for Campus-based Laboratories at the University of Rijeka” project financed by ERDF
Contacts	Assoc. Prof. D. Sc. Gabiela Ambrožić (+385 51 584 632, gabriela.ambrozic@phy.uniri.hr)