

**Description of infrastructural capacity of  
DISTRIBUTED INFRASTRUCTURE OF CENTERS FOR INVESTIGATIONS OF NEW MATERIALS AND THEIR  
APPLICATIONS AND FOR RESEARCH AND CONSERVATION OF ARTEFACTS  
(ARCHEOLOGICAL AND ETHNOGRAPHIC)**

**ACRONYM: INFRAMAT**

<b><i>INFRAMAT – Technical characteristics</i></b>
<b>Partner 1</b>
<b>Institute of Physical Chemistry "Rostislav Kaischew"– Bulgarian Academy of Sciences</b>
<b><i>Infrastructural laboratory and/or equipment</i></b>
<ol style="list-style-type: none"> <li>1. Electron Microscopy and Microanalysis</li> <li>2. Laboratory of X-ray Diffraction Methods</li> <li>3. Computed Tomography</li> <li>4. X-ray Fluorescence analysis</li> <li>5. Neutral salt spray chamber with possibility to explore in dynamic mode</li> <li>6. Profile Analysis Tensiometer for investigation of fluid interfaces</li> <li>7. Equipment for electrochemical measurements</li> <li>8. Optical Dilatometer with High Temperature Microscope</li> </ol>
<b><i>Description of the equipment:</i></b>
<ol style="list-style-type: none"> <li>1. The Laboratory of electron microscopy and microanalysis at IPC is the first electron microscopy servicing laboratory within Bulgarian academy of sciences. More than fifty years we support the main scientific projects and goals of IPC as well as other institutes in the framework of Bulgarian academy of sciences. We are also available for consultancy and contract work. Our equipment includes two JEOL electron microscopes, energy dispersive detector for all elements including Carbon. We offer images at secondary and back-scattered electrons, line scan analysis, elemental mapping, sample preparation.</li> <li>2. The Laboratory of x-ray diffraction methods and computed tomography was founded in 2015 as significant improvement of the already existing laboratory of x-ray diffraction. The laboratory covers a wide spectrum of structural X-ray studies on nano- and micro- level of monolithic polycrystalline samples, powder samples and thin films. The diffractometer has opportunities for small-angle diffraction, grazing incident x-ray diffraction, small-angle scattering, micro-diffraction, reflectometry, investigation of texture and residual stresses and measurements at high temperatures in protective environment.</li> <li>3. The computerized X-ray tomography allows non-destructive testing with high resolution in the entire volume (3D) of various materials, biological objects, archaeological artifacts and other objects that can be penetrated by the X-ray radiation of the device.</li> <li>4. The X-ray fluorescence analysis is a method used for qualitative and quantitative elemental analysis of solid, liquid and powdered materials as well as thickness and percentage composition of single and multilayer coatings composed of elements with numbers between calcium (20) and uranium (92). It is a quick non-destructive method allowing the local qualitative and quantitative determination of the sample composition at concentrations between 0.1 and 100 wt. %. The use of appropriate software allows precise determination of material composition and thickness of coatings and their visualization as well as video-monitoring. The method allows the material to be analyzed at a small depth below its surface up to hundred micrometers and is unable to extract information from a larger depth of solid metal samples.</li> <li>5. The apparatus allows for standardized, continuous and cyclical and/or multi-step tests such as NSS, AASS and CASS according to EN ISO 9227; ASTM G85, Annex1,2,3 &amp; 5; DIN 50021; ASTM B117; ISO 6270-2; ISO 7253; ASTM D1735; ASTM D2247; ASTM D5894; and similar, as well as</li> </ol>

<p>some specialized corrosion tests applied in the automotive industry. The main supported operating modes are: salt spray; relative humidity of 95% to 100%; drying with forced air („dry-off“); drying without forced air ("dwell"). The maximum working temperature is up to +60 °C for the tests "Salt Spray", "Relative Humidity", "Drying without forced air", etc., and up to + 70 °C for the "Dry-off" test.</p> <p>6. This instrumentation (PAT.1, Sinterface) allows: (1) precise experimental measurement of dynamic surface tension values at fluid interfaces; (2) reliable determination of equilibrium surface tension values; (3) investigation of the dynamic and equilibrium rheological characteristics of the adsorption layers at fluid interfaces (surface dilation elasticities and viscosities); (4) investigation of the spreading kinetics of liquid droplets on solid substrate; (5) reliable determination of equilibrium contact angle values of liquid droplets on solid substrate. The setup has a frequency generator for surface rheology experiments, CCD camera, and specific double dosing system for experiments with continuous mixing in real time.</p> <p>7. Four complex equipment for electrochemical studies (Autolab, Ivium, Gamry and PAR) with options for impedance measurements, rotating disk electrode and electrochemical quartz microbalance and software providing flexible opportunities for various regimes of synthesis, characterization, electrocatalytic and electroanalytical measurements and electrochemical corrosion tests.</p> <p>8. Contactless Horizontal Optical Dilatometer and High Temperature Microscope for operation in the range 20-1400 ° C (Misura HD / HTM 1400 - Expert System Solution)</p>
<b>Partner 2</b>
<b>Institute of Balkan Studies with Centre of Thracology – Bulgarian Academy of Sciences</b>
<b>Infrastructural laboratory and/or equipment</b>
Electronic Database – Online Encyclopaedia <i>Ancient Thrace and the Thracians</i>
<b>Description of the equipment:</b>
<p>1. Texts and images on different spheres of issues related to the history of Ancient Thrace in the large context of ancient history are presented in 17 categories; the Thracian language in Indo-European context (anthroponymy, hydronymy, toponymy) is presented in articles and based on different monuments: literary sources, epigraphic and numismatic data; Thracian religiousness and cultural relations are introduced through evidence in ancient literature, numismatics, epigraphy, art and sacral architecture; 22 maps outline the Thracian territory during different periods, and highlighting important events in Thracian history, emblematic sites related to metallurgy and to metal deposits; the most important routes via Thrace from the Bronze Age to the end of the Roman period, used for the economic, political and cultural contacts of Thrace with the surrounding world; a glossary contains specific terminology; many ancient authors related to the studies are presented in a separate section; an extensive bibliography of the studies is compiled. All articles are with references related to the research issues;</p> <p>2. At the moment the Electronic Database includes ca. 700 text units, ca. 600 annotated images of different artefacts: metal and clay vessels, coins, horse trappings, jewellery, gravestones and votive tablets, inscriptions, architectural sites – dolmens, tombs, settlements, etc.;</p> <p>3. The <i>Electronic Database – Online Encyclopaedia Ancient Thrace and the Thracians</i> is intended to be used by researchers, students, scholars and by large audiences with interests in ancient history.</p>
<b>Partner 3</b>
<b>Institute of Ethnology and Folklore Studies with Ethnographic Museum- Bulgarian Academy of Sciences</b>
<b>Infrastructural laboratory and/or equipment</b>
Laboratory for Analysis, Conservation and Restoration

<p><b>Description of the equipment:</b></p> <p>Trinocular microscope OZL 464 with 1.3MP microscope camera  Equipment for preservation and restoration- to the microscope - computer, camera for documentation of restoration interventions, dirt and soldering iron, refrigerator for storing chemicals, ultrasonic washing machine, ironing system, textile-restoring textiles, dyeing tank, water purification system.  All these devices provide the opportunity for preliminary investigation and identification of causes for destruction; ensure a level of conservation-restoration intervention consistent with the best established practices.</p>
<p><b>Partner 4</b></p> <p><b>Institute of Electrochemistry and Energy Systems- Bulgarian Academy of Sciences</b></p> <p><b>Infrastructural laboratory and/or equipment</b></p> <p>Laboratory for Electrochemical Material Testing</p>
<p><b>Description of the equipment:</b></p> <p>Electrochemical work station with advanced testing set up: Potentiostat/Galvanostat ELPAN 21, Frequency Analyser ELPAN 20, Sygnal Generator ELPAN20 Equipment for Electrochemical noise measurements (own design), EasyTest Cell (own design and methodology), advanced electrochemical cells for aqueous, polymer, and solid state electrochemistry, infrastructure for precise control of test temperature and gas atmosphere</p>
<p><b>Partner 5</b></p> <p><b>Institute of Catalysis- Bulgarian Academy of Sciences</b></p> <p><b>Infrastructural laboratory and/or equipment</b></p> <ol style="list-style-type: none"> <li>1. JEOL JES – FA 100 ESR spectrometer;</li> <li>2. ESCALAB MkII electron spectrometer;</li> <li>3. Equipment for infrared spectroscopy;</li> <li>4. Gas Chromatograph with Quadrupole Mass Spectrometric Detector;</li> <li>5. Mössbauer Spectrometer “WissEl - Wissenschaftliche Elektronik GmbH”;</li> <li>6. Catalytic equipment for complete oxidation of volatile organic compounds (VOC) and CO oxidation in hydrogen rich gases;</li> <li>7. Catalytic equipment for methane reforming.</li> </ol>
<p><b>Description of the equipment:</b></p> <ol style="list-style-type: none"> <li>1. JEOL JES – FA 100 ESR spectrometer working in X – band; two ranges of temperature are available: 50 °C to 150 K and 150 K to 50 °C;</li> <li>2. ESCALAB MkII electron spectrometer (VG Scientific, now part of Thermo Fischer Scientific)  Depending on the needs of experiment the apparatus can be adjusted, for example gases can be used for catalytic reactions. The sample can be cooled down to 100K and heated up to 950 K. A larger surface area can be investigated up to 7x3 mm of solid and powder samples using twin unmonochromatized anode MgK/AlK;</li> <li>3. Nicolet 6700 FTIR, Thermo Electron Corporation, USA, 2006. Detector and beam splitter for far (250–600 cm<sup>-1</sup>) IR region; Diffuse-reflectance accessory (400–4000 cm<sup>-1</sup>); High temperature vacuum chamber about in situ investigations in region of 1111–4000 cm<sup>-1</sup> (temperatures up to 500 °C, vacuum down to 10<sup>-5</sup> mmHg, pressure up to 2 atm) based on diffuse-reflectance; Vertical ATR accessory (400–4000 cm<sup>-1</sup>).</li> <li>4. Gas Chromatograph with Quadrupole Mass Spectrometric Detector High Performance System for separation and analysis of molecular mixtures of compounds, whose identification is automatically accomplished via registration and comparison of their mass spectra with a library spectral database;</li> <li>5. <sup>57</sup>Fe Mössbauer Spectroscopy;</li> <li>6. Flow type glass reactor with an inner diameter of 8 mm. The reactor is placed in a vertical tube</li> </ol>

furnace. The temperature is regulated by RT-290 (Comeco) temperature controller. The reaction temperature is measured by internal thermocouple. The gas flow rates are regulated by mass-flow controllers Matheson. The reaction products are analyzed by a Varian 3700 gas chromatograph equipped with thermal conductivity detector, flame ionization detector and 3 m column with Porapak Q (0.150–0.180 mm, Riedel-de Haën AG D-3016 Seelze 1);

7. Fixed-bed continuous flow reactor consisting of a quartz tube with an inner diameter of 6 mm and a length of 300 mm. The tube is placed in a vertical tube furnace. The temperature is regulated by RT-290 temperature controller. The gas flow rates are regulated by mass-flow controllers Matheson. The reaction products were analyzed in a gas chromatograph TRACE GC Ultra, Thermo Fisher Scientific.

#### **Partner 6**

**Institute of General and Inorganic Chemistry (IGIC), Bulgarian Academy of Sciences**

#### **Infrastructural laboratory and/or equipment**

1. Bruker D8 Advance with LynxEye detector;
2. Flame atomic absorption spectrometer (Flame-AAS) , Thermo Elemental SOLAAR - M5 AA, Thermo Fisher Scientific (USA);
3. High Resolution Scanning Transmission electron microscope;
4. UV-VIS spectrophotometer Thermo Evolution 160;
5. Thermo Evolution 300 DR UV-vis spectrometer equipped with a diffuse-reflectance Praying Mantis device;
6. Thermo Nicolet 6700 FTIR spectrometer with DTGS and MCT detectors;
7. ThermoScientific Nicolet iS5 FTIR spectrometer with DTGS detector;
8. Thermal conductivity Instrument C-Therm Technologies Ltd;
9. Equipment for thermal analysis;
10. Hall measurement system MMR Technologies Inc;
11. Quantachrome Nova 1200e analyser;
12. X-ray photoelectron spectrometer AXIS Supra (Kratos Analytical Ltd);
13. Multifrequency electron paramagnetic resonance spectrometer (Bruker EMXplus);
14. Inductively coupled plasma optical emission spectrometer (ICP-OES) Prodigy 7 ICP-OES, Teledyne Leeman Labs (USA).

#### **Description of the equipment:**

1. Bruker D8 Advance with LynxEye detector;
2. Double-beam atomic absorption spectrometer. Wavelength range: 180-900 nm. Echelle monochromator;
3. HR STEM JEOL JEM 2100, acceleration voltage 200 kV, maximum resolution – 0.23 nm between two points, maximum magnification 1500000x in conventional and 2000000x in scanning mode;
4. Double beam spectrophotometer, collect molecular absorption spectra in solutions of organic complexes of transition metal ions and various organic compounds in the range of 190- 1100 nm;
5. Allows recording transmission and diffuse-reflectance UV-vis spectra of solid or liquid samples. The spectra are recorded in the 190-1100 nm wavelength range;
6. Allows recording transmission FTIR spectra of solid samples in KBr pellets at room temperature. The spectra are recorded in the 4000-400 cm<sup>-1</sup> spectral range. Oxides, zeolites, metal-organic frameworks (MOFs), adsorbents, catalysts and other powdered samples can be investigated;
7. A purpose-made IR cell, directly connected to vacuum-adsorption apparatus, permits investigation of pure powdered samples in self-supporting pellets, both at room temperature and at 100 K (-197°C). The technic allows determining surface acidity and studying interactions occurring on the solid surfaces in atmosphere of different gases;
8. Allows measuring the thermal conductivity of solid and powdered materials at room temperature. Offers calculation of diffusivity, heat capacity and depth of penetration;
9. Equipment for differential thermal and thermogravimetric (DTA-TG) analysis combined with a

<p>mass spectrometer:</p> <ul style="list-style-type: none"> <li>- DTA/TG anapar - LABSYSTEM Evo –1600, Setaram, France;</li> <li>- MASSPECTROMETER – Pfeiffer vacuum;</li> </ul> <p>10. Based on the Van der Pauw method, the equipment allows to measure automatically of resistivity, mobility and carrier concentration of solid samples over a temperature range from 100K to 600K;</p> <p>11. Analyzer for automatic determination of specific surface area and pore-size distribution;</p> <p>12. The apparatus is used for quantitative and qualitative chemical analysis of the uppermost atomic layers of solids surfaces by X-ray photoelectron spectroscopy (XPS). The AXIS Supra (Kratos Analytical Ltd.) electron spectrometer has the following characteristics:</p> <ul style="list-style-type: none"> <li>- Monochromatic Al K<math>\alpha</math> and Ag L<math>\alpha</math> X-ray sources with photon energies of 1486.6 eV and 2984.3 eV, respectively;</li> <li>- Achromatic Al K<math>\alpha</math> and Mg K<math>\alpha</math> X-ray sources with photon energies of 1486.6 eV and 1253.6 eV;</li> <li>- Neutralization system against the surface charging due to electron photoemission;</li> <li>- Cleaning the sample surfaces using ion bombardment (with Ar + ions), followed by chemical analysis (depth profiling);</li> <li>- Analysis at different angles to the surface (only for atomic smooth surfaces);</li> <li>- Chemical imaging of the surfaces;</li> <li>- Software processing of the measured spectra using a company program ESCApe.</li> </ul> <p>13. Multyfrequency EPR spectrometer operating at two radiofrequencies: fixed 9 GHz (X-band) and 35 GHz (Q-band). UV-system for measurement of photoactive substances. Variable temperature unit for low and high temperature experiments: from 70 to 500 K. Flat cell cuvette for analysis of liquids. Quartz tubes for measurement of powdered samples;</p> <p>14. Simultaneous inductively coupled plasma optical emission spectrometer, ICP Plasma RF - 40 MHz; high resolution Echelle polychromator and solid state CMOS detector.</p>
<b>Partner 7</b>
Institute of Optical Materials and Technologies - Bulgarian Academy of Sciences
<b>Infrastructural laboratory and/or equipment</b>
<ol style="list-style-type: none"> <li>1. Solid State Pulsed Laser Systems;</li> <li>2. X-ray Analysis System</li> <li>3. Scanning Transmission electron microscope HRTEM JEOL JEM 2100</li> <li>4. Spectroscopic Phase Modulated Ellipsometer UNIVESEL 2, Horiba JobinYvon</li> <li>5. Atomic force microscope MFP-3D, Asylum Research, Oxford Instruments</li> <li>6. 3D Optical profiler, Zeta-20, Zeta Instruments</li> <li>7. Spectrofluorometer FluoroLog3-22, Horiba JobinYvon</li> <li>8. Dynamic Light Scattering, (DLS), Zetasizer Nano ZS, Malvern</li> <li>9. Laser systems with continuous emission mode and holographic equipment</li> <li>10. Glovebox workstation MB-200, MBRAUN</li> </ol>
<b>Description of the equipment:</b>
<ol style="list-style-type: none"> <li>1. Argon gas laser at 476 nm, 488 nm and 514 nm. Two pulse Nd:YAG lasers, from B.M. Industries Series 5000 (<math>\lambda = 1064</math> nm) with option for second, third and forth harmonic generation (532, 355 and 246 nm). Repetition rate: 20 Hz and 10 Hz, pulse duration: 10 ns. Optical parametric oscillator OP 901 (B.M. Industries). Two power meters for energy measurements: LEM 2020 (Spectrolas), RJ-7620 (Laser precision corp.). Power meter Liconix 45PM.</li> <li>2. X-ray diffractometer "Philips 1710" – with monochromatic Cu-K<math>\alpha</math> emission and Bragg-Brentano focusing geometry.</li> <li>3. High Resolution Scanning Transmission electron microscope HR STEM JEOL JEM 2100 acceleration voltage 80 - 200 kV, maximum resolution – 0.23 nm between two points, maximum magnification 1500000x in conventional and 2000000x in scanning mode, with 5 basic regimes – bright field and dark field microscopy, diffraction from selected and nano sized area and diffraction in focused beam. Equipped with CCD camera GATAN Orius 832 SC1000 and GATAN</li> </ol>

Microscopy Suit Software.

4. Spectral range 190-2100 nm. Double Monochromator System for UV-Vis range. Computer controlled variable angle goniometer with angle range 35° - 90° in steps of 0.01°, allowing variable angle spectroscopic ellipsometry (VASE). Computer controlled 200mmx200 mm XYZ stage. Computer controlled microspots- choice of 8 different spot size to suit the feature size of sample. Temperature controlled cell+600 °C. Electrochemical cell. Sealed cell for thin film characterization under non-air ambient conditions. DeltaPsi software for controlling all hardware operation of the system, data acquisition, sample structure modeling, ellipsometric measurements analyses.
5. Piezo driven flexure stage XY scanner with 90µm scan range and <0.5nm sensor noise (ADev,0.1Hz-1kHz), noise sensor non-linearity <0.05% (ADev/full travel) operates in both open-loop and closed-loop, with completely separated axes avoiding crosstalk; Sensored Z scanner with 15µm range for both open-loop and closed-loop operation with <0.25nm sensor noise and sensor non-linearity <0.05%.
6. An optical microscope that provides a three-dimensional image of the surface of the specimen, and can examine both very low reflection and large-specimen specimens. Vertical (Z) resolution <1 nm. Field of view from 0.006 mm<sup>2</sup> to 15 mm<sup>2</sup>. Increase 5x, 20x, 50 and 100x. Submicronal lateral resolution. Fast response <1 minute. Integrated Spectrum Reflectometer allowing measurement of multilayer stack thickness or n & k values if known thickness (spectral range: 430-750 nm, thickness range 30-50,000 nm).
7. Double-grating monochromators in excitation and emission in the range 200-950nm. Bandpass: Ex. & Em. 0-15nm, continuously adjustable from computer. Wavelength accuracy +/- 0.5nm. Scan speed 150nm/s. Water Raman Signal min. 400.000cps, EX=350nm, EM=397nm, BP=5 nm, integration=1s; S/N Ratio =10 000/1 (FSD). TCSPC lifetime with NanoLed pulsed laser diode (375 nm), minimum measurable lifetime of 30 ps with PPD detector.
8. Equipped with accessory for Zeta potential measurements of solid surfaces and viscometer. Conduction of measurements in wide temperature range: 0-120°C.
9. Holographic stands - 4 pcs; diode-pumped solid state laser Verdi 12W, 532 nm from Coherent Inc.; gas laser HeCd, 442 nm, Soliton-Kimmon; diode-pumped solid state lasers Cobolt Calypso DPSS - 200 mW, 491 nm and Cobolt Zouk - 10mW, 355 nm; diode-pumped solid-state laser, 594 nm, 50mW; laser diode system OBIS LX, 150mW, 488 nm, Coherent Inc.; laser diode system OBIS LS, 20mW, 514 nm, Coherent Inc.; diode lasers in the red and infrared areas, 660 nm, 790 nm, 830 nm; monochrome, color and high speed CCD recording system and CMOS camera.
10. Glovebox workstation MB-200, MBRAUN with fully integrated high vacuum chamber (< 2x10<sup>-6</sup> mbar). The box is supplied with a gas purification system MB-20-G-W-V2A for closed cycle circulation of the inert gas with oxygen and moisture sensors as well as filtering and regeneration columns. The system provides automatic box pressure control in adjustable range between -15 to +15 mbar, keeps super low (< 1 ppm) concentrations of O<sub>2</sub> and H<sub>2</sub>O in the inert gas and has filtering capacity of 36 L O<sub>2</sub> and 1300 g H<sub>2</sub>O.

**Partner 8**

**Institute of Organic Chemistry with Centre of Phytochemistry - Bulgarian Academy of Sciences**

**Infrastructural laboratory and/or equipment**

**MODULE 1**

1. Laboratory Bulgarian NMR Centre;
2. Laboratory Organic Synthesis and Stereochemistry;
3. Laboratory of Biologically Active Substances.

**MODULE 2**

1. Laboratory of Structural Organic Analysis

**Description of the equipment:**

**MODULE 1**

## 1. **NMR spectrometer Bruker Avance II+ 600**

### **Magnet**

- Ultrashield™ magnet D 262/54, 14.09 T, <sup>1</sup>H working frequency 600.01 MHz
- Three radiofrequency channels with liner amplifiers (BLAXH2H 300/100/150, BLAX 500)
- Standard high resolution gradient amplifiers – GAB, GREAT 1/10, with maximum output current of 10 A; Z gradient system; maximum gradient strength at 100% - 53 G/cm.
- GREAT 1/40 amplifier with maximum output current of 40 A; Z gradient system; maximum gradient strength at 100% - 1180 G/cm
- Gradient master unit (BGMUI);
- Automatic pneumatic unit (MAS II)
- Automatic sample changer B-ACS for 60 samples

### **Probeheads:**

- 5 mm direct dual probehead (BBO, 31P - 109Ag/1H); with actively shielded Z-gradients
- 5 mm inverse triple probehead (TBI, 1H/31P - 109Ag/13C); with actively shielded Z-gradients
- MIC-Diff30 diffusion dual probehead 1H/31P; with actively shielded Z-gradients
- 4 mm CP/MAS dual probehead 31P - 15N/1H for solid state;
- 4 mm HRMAS dual probehead 1H/13C with MAS gradient system; for the investigation of gels, soft and microheterogeneous materials, and phenomena at liquid-solid interfaces;

### **Temperature control units:**

- B-VT 3000 with temperature range 150 - 390 K
- BCU 5 with temperature range 233 - 323 K
- BCU20 with water cooling system for temperature control on MIC-Diff30 probe.

### **Computer and Software:**

- PC LINUX workstation HP z400
- Topspin 3.5pl.3, NMR Guide

## **NMR spectrometer Bruker DRX 250**

### **Magnet**

- Magnet (131/52), 5.87 T, <sup>1</sup>H work frequency 250 MHz, <sup>1</sup>H working frequency 600.01 MHz
- Two radio frequency channels with liner amplifier BLAXH40
- Gradient unit GRASPII 10A, Z gradient system; maximum gradient strength at 100% - 53 G/cm.

### **Probeheads:**

- 5 mm direct dual probehead (BBO) <sup>31</sup>P - <sup>109</sup>Ag / <sup>1</sup>H, with actively shielded Z-gradients
- 5 mm quattro probehead (QNP) <sup>1</sup>H, <sup>13</sup>C, <sup>31</sup>P, <sup>19</sup>F with actively shielded Z-gradients
- 5 mm dual probeheads - <sup>1</sup>H / <sup>13</sup>C
- 10 mm direct broadband probeheads - <sup>31</sup>P - <sup>15</sup>N / <sup>1</sup>H
- 10 mm direct broadband probeheads - <sup>15</sup>N - <sup>109</sup>Ag / <sup>1</sup>H

### **Temperature control:**

- Temperature unit - B-VT 2000 with temperature range 170 - 450 K
- Temperature unit BCU with temperature range 268 - 323 K

### **Computer and Software:**

- PC LINUX workstation HP xw 4300
- Topspin 1.3, NMR Guide

## 2. **High-performance Liquid Chromatograph Agilent 1100**

Analytical apparatus for the separation of complex mixtures of synthetic and natural origin for quantitative and qualitative determination of the components. Integrated analysis system for samples for routine and R&D analysis. There are columns for identifying different groups of substances.

### **Supercritical Carbon Dioxide Extraction Apparatus Separex (1000 bar)**

Modular system for extraction of aromatic and medicinal plants with supercritical carbon

dioxide.

**BUCHI Sepacore® flash system with Fraction Collector C-660, UV-Vis Detector C-640 and two pumps C-605 working in isocratic or gradient mode**

Fully automated module system for preparative flash chromatography with binary gradient. It includes 3-piston chemically inert and biocompatible pumps working in isocratic or binary mode with 2.5 ml/min–250 ml/min flow rate. The pressure is in the range from 0 to 50 bar. Suitable for all flash purification requirements. Choice of four collection patterns and adjustable height for optimal integration in your workflow. UV- VIS detector with up to eight detector signals in the range 200-840 nm. Large collection capacity for long runs or high flow rates. The SepacoreControl software gives full advantage of the highest modularity and flexibility of the Sepacore flash chromatography systems.

**BUCHI Mini Spray Dryer B-290 System working with both aqueous and organic solutions**

With the Mini Spray Dryer B-290 it is possible to spray with organic solvents without risk of explosion, because the system works under inert conditions.

**Encapsulator BUCHI B-395. Apparatus for sterile microbeads and microcapsules.**

Apparatus for encapsulation in sterile conditions in a closed reaction vessel. Built-in controller with sensitive LCD screen for visualization and vibration frequency adjustment, electrostatic spraying, pump flow rate, stirring intensity. Encapsulation under sterile conditions - all parts in contact with the product and the feed mixture are autoclaved. Completely autoclavable reactor made of glass and stainless steel for sterile production and collection of microbeads and core-shell capsules, 2 L working volume. Includes a pulsation chamber for single nozzle system. Concentration nozzle set for encapsulation in gelatin shell.

**Microwave Reaction System: Multiwave PRO - Apparatus for Extraction of Medicinal and Aromatic Plants**

Modular microwave system for the extraction of medicinal and aromatic plants. Chamber volume of 66 liters. Two magnetrons of industrial type.

**Digital Polarimeter Jasco P-2000**

Readout modes: optical rotation, specific rotation, optical purity, concentration, sugar scale, Brix scale. Temperature readout range 0 - 40 °C ± 0.1°C. Two temperature sensors, one is moveable and can measure temperature directly in the sample, the other is built into the cell holder. Max. cell length: 100 mm. In maximum outfit applicable wavelength range 250 – 880 nm. Sodium and Mercury lamp sources.

3. **SKALAR apparatus for automatic determination of uronic acids and total neutral sugars.**

**MODULE 2**

Tensor 27 Bruker FTIR spectrometer with working spectral range 8000 – 400 cm<sup>-1</sup> at maximum resolution 0.5 cm<sup>-1</sup>, equipped with:

- a reflection attachment (ATR) with a diamond plate for measuring solid and liquid samples;
- hydraulic press for preparation of KBr & CsJ tablets used for recording solid sample IR spectra;
- KBr, CaF<sub>2</sub> cells for IR measurements in solution.

**Partner 9**

**Institute of Polymers- Bulgarian Academy of Sciences**

**Infrastructural laboratory and/or equipment**

1. Equipment for thermal analysis ;
2. Equipment for X-ray structural analysis;
3. Equipment for spectrophotometric analysis;
4. Equipment for physico-mechanical testing of polymer and composite materials;
5. Equipment for extrusion, compounding and granulation of polymer composites;
6. Equipment for gas chromatography;



<p>7. Equipment for molecular mass determination;</p> <p>8. Equipment for atom force microscopy;</p> <p>9. Equipment for investigation of polymer solutions and colloid systems applying static/dynamic and electrophoretic light scattering;</p> <p>10. Equipment for measurement of surface tension of liquids and dynamic contact angle.</p>
<p><b>Description of the equipment:</b></p> <p>1. Differential scanning calorimeter Perkin Elmer DSC-8500 (from -130 °C to 900 °C) Thermogravimetric analyzer PerkinElmer TGA4000; Combined thermogravimetric analyzer with gas chromatograph and mass-selective detector (TGA/GC/MS) for analysis of the products from the thermal decomposition of materials.</p> <p>2. X-ray diffractometer D8 Advance ECO Bruker AXS.</p> <p>3. UV-VIS spectrometer DU 800 (Beckman Coulter); IRAffinity-1 “Shimadzu” Fourier Transform Infrared (FTIR) spectrophotometer with MIRacle Attenuated Total Reflectance Attachment.</p> <p>4. Testing machines HZ-1005B and INSTRON 3344; Dynamic Mechanical Analyzer DMA Q 800 (TA Instruments); Universal modular rheometer RheoStress 600, Thermo Haake; Hydraulic laboratory press for preparation of standard samples.</p> <p>5. The HAAKE MiniLab II Micro twin-screw compounder; Single-screw compounder LDC-SJP-35.</p> <p>6. Gas Chromatograph Agilent 7890B with a flame-ionization detector and an Agilent 7693A automatic liquid sampler.</p> <p>7. Analytical ultracentrifuge ProteomeLab XL-I Beckman Coulter; Nexera XR Ultra High Performance Liquid and Gel Permeation Chromatograph GPC line equipped with set of three detectors: RI, UV and LS (Waters Alliance GPC, Wyatt T-rEX, Wyatt HELEOS II); Automatic viscometer Canon PolyVISC .</p> <p>8. Atomic Force Microscope BRUKER DIMENSION ICON with ScanAsyst®.</p> <p>9. The equipment includes a goniometer BI-200SM and zetasizer 90Plus PALS, Brookhaven Instruments; Orange Analytics DNDC 19 for determination of gradient of the refractive index.</p> <p>10. Tensiometer K100 of KRÜSS.</p>
<p><b>Partner 10</b></p>
<p><b>National Museum of History</b></p>
<p><b>Infrastructural laboratory and/or equipment</b></p>
<p>Central Laboratory for Conservation and Restoration (CLCR)</p>
<p><b>Description of the equipment:</b></p>
<p>The laboratory is equipped for conservation and restoration of movable cultural valuables of metals, ceramics, stone, wood, textile and bone, as well as of cultural valuables on paper, easel and wall paintings, as follows: stereomicroscopes, ultrasonic baths, vacuum drier, micromotors, grinding and polishing motors, specialized for conservation and restoration sandblaster, steam-cleaner, personal tools, etc.</p>
<p><b>Partner 11</b></p>
<p><b>National Archaeological Institute with Museum- Bulgarian Academy of Sciences</b></p>
<p><b>Infrastructural laboratory and/or equipment</b></p>
<p>Laboratory for Analysis, Conservation and Restoration, XRF analysis</p>
<p><b>Description of the equipment:</b></p>
<p>XRF spectrometer, Shimadzu EDX-720 – the instrument is giving possibility for analyzing objects in most of the cases without sampling because of the big chamber it is equipped with (d – 30 cm, H – 15 cm); an advantage of the machine is that analysis can be performed in vacuum; for safety</p>

<p>reasons and requirements of the law it is convenient the objects to be study in within the building of the museum.</p> <p>The equipment for the conservation treatment of the archaeological artifacts – climate controlled environment, microscopes, micro-sanding machine, ultrasonic machines, etc. guaranties conservation treatment according the best established practices.</p>
<b>Partner 12</b>
<b>National Academy of Art</b>
<b>Infrastructural laboratory and/or equipment</b>
Research Laboratory for Conservation-Restoration
<b>Description of the equipment:</b>
<ol style="list-style-type: none"> <li>1. Professional camera Fujifilm UVIR Pro with lenses, filters, tripods and light.</li> <li>2. Microscopes Amplival, Neophot</li> <li>3. Stereo microscopes Carl Zeiss – Jena</li> <li>4. Equipment for micro chemical analyses and liquid chromatography</li> <li>5. Data logger KlimaLogg Pro with external sensors</li> <li>6. Thermal camera</li> </ol>
<b>Partner 13</b>
<b>New Bulgarian University</b> - not supported as a private institution
<b>Partner 14 (1)</b>
<b>Faculty of Chemistry and Pharmacy – Sofia University "St. Kliment Ohridski"</b>
<b>Infrastructural laboratory and/or equipment</b>
<ol style="list-style-type: none"> <li>1. Scanning Electron Microscopy Laboratory;</li> <li>2. Transmission Electron Microscopy Laboratory;</li> <li>3. Atomic Force Microscopy Laboratory;</li> <li>4. Nuclear Magnetic Resonance Laboratory;</li> <li>5. Atomic Absorption Spectroscopy Laboratory;</li> <li>6. Chromatography Laboratory.</li> </ol>
<b>Description of the equipment:</b>
<ol style="list-style-type: none"> <li>1. Scanning Electron Microscope JEOL 5510;</li> <li>2. Transmission electron microscope JEOL JEM-2100;</li> <li>3. Atomic force microscopy NanoScope V system (Bruker Ltd, Germany). Caliber (Bruker Ltd, Germany);</li> <li>4. Bruker Avance III 500MHz NMR Spectrometer;</li> <li>5. Atomic-absorption spectrometer Perkin Elmer AAnalyst 400, equipped with modules for atomization with flame (general module), graphite furnace (HGA 900), hydride generation (MHS 15) and autosampler AS 800. Electrothermal atomic-absorption spectrometer with Zeeman corrector Perkin Elmer Zeeman 3030. Atomic-absorption spectrometer Varian AA240 with possibility for flame (general module) and hydride (VGA77) atomization. Flame atomic-absorption spectrometer Pye Unicam SP1950;</li> <li>6. Gas chromatograph HP 5890 series II equipped with Split/splitless and on-column injectors, Flame Ionization Detector. Gas chromatograph HP 6890 equipped with Split/splitless and on-column injectors, EI-mass detector. High Performance Liquid Chromatograph KONIK HPLC 560 equipped with Diode Array Detector.</li> </ol>
<b>Partner 14 (2)</b>
University of Sofia, Faculty of Physics
<b>Infrastructural laboratory and/or equipment</b>
Spectroscopy of Solids Laboratory

<b>Description of the equipment:</b>
<ol style="list-style-type: none"> <li>1. Micro-Raman spectrometer LabRAM HR Visible (HORIBA Jobin Yvon) equipped with a microscope Olympus BX41, objectives X10, X20, X50, X50LWD, X100, edge-filters for 4 laser lines (633 nm, 515 nm, 488 nm, 458 nm), options for obtaining of polarized Raman spectra in different scattering configurations (using lambda/2 plate and a polarizer);</li> <li>2. He-Ne laser (633 nm), Ar+ ion laser (515 nm, 488 nm и 458 nm);</li> <li>3. Optical cell LINKAM TH600 for measurements at different temperatures (77 K – 600 deg C).</li> </ol>
<b>Partner 14 (3)</b>
<b>University of Sofia, Faculty of Chemistry and Pharmacy (&amp; Faculty of History)</b>
<b>Infrastructural laboratory and/or equipment</b>
<ol style="list-style-type: none"> <li>1. Laboratory of trace analysis: ICP techniques and Radioanalytical methods;</li> <li>2. Conservation and Restoration Laboratory.</li> </ol>
<b>Description of the equipment:</b>
<ol style="list-style-type: none"> <li>1. Inductively Coupled Plasma Mass Spectrometry (Perkin Elmer SCIEX DRC-e ICP-MS) equipped with laser-ablation system (LA-ICP-MS, New Wave Research) and on-line liquid chromatographic section (LC-ICP-MS); Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES, Perkin Elmer Optima 7000 DV); High Performance Liquid Chromatography equipment with a diode array detector (HPLC-DAD, VARIAN ProStar system); Gamma spectrometer; Microwave oven (Anton Paar, Multiwave 3000).</li> <li>2. Handheld XRF Analyzer S1 TITAN 800, Bruker; ARTLASER LAMBDA SpA.</li> </ol>
<b>Partner 15</b>
<b>University of Chemical Technology and Metallurgy, Laboratory for advanced materials research (LAMAR)</b>
<b>Infrastructural laboratory and/or equipment</b>
<ol style="list-style-type: none"> <li>1. Universal Equipment for electrochemical analyses;</li> <li>2. Atomic Force Microscopy;</li> <li>3. Equipment for determination of the superficial hydrophobicity;</li> <li>4. Equipment for adhesion between a coating and its substrate measurements.</li> </ol>
<b>Description of the equipment:</b>
<ol style="list-style-type: none"> <li>1. Universal electrochemical device type Autolab – 30, Potentiostat/Galvanostat. Integrated FRA-2 frequency response analyzer unit. Electrochemical flat cells ISO 16773, for long term tests combined with exposure to model corrosive media at room temperature;</li> <li>2. Easyscan-2 of Nanosurf (Swiss), equipped by Budgetsensor cantilevers (Bulgaria);</li> <li>3. Theta Lite Optical Contact Angle Meter, product of “Dynatesting co. (UK)”, in complete with precise Gastight-1001 type syringe, of “Hamilton (Nevada, USA)”;</li> <li>4. Positest A-TA, product of DeFelsko (USA).</li> </ol>
<b>Partner 16</b>
<b>Central Laboratory of Applied Physics - Bulgarian Academy of Sciences</b>
<b>Infrastructural laboratory and/or equipment</b>
<ol style="list-style-type: none"> <li>1. High-technological equipment Platit π80+ for cathodic-arc deposition;</li> <li>2. High-technological equipment UDP 850-4;</li> <li>3. Multifunctional equipment Compact Platform CPX-MHT/NHT.</li> </ol>
<b>Description of the equipment:</b>
<ol style="list-style-type: none"> <li>1. Equipment Platit π80+ of the Swiss company PLATIT for cathodic-arc deposition of nanostructured, multilayer and gradient superhard coatings and nanocomposites;</li> <li>2. Equipment UDP 850-4 of the UK company Teer Coatings for deposition by unbalanced</li> </ol>

magnetron sputtering of ecological nanosized monolayer and multilayer, gradient and composite coatings with low friction coefficient;

3. Equipment of the Swiss company CSM Instruments (currently Anton Paar) for characterization of the mechanical parameters of thin films, including nanocomposites, and bulk materials.

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