MAGNETISM AND LOW TEMPERATURE LABORATORIES

MISSION

Magnetism and Low Temperature Laboratories - MLTL (http://mltl.eu/) operated by the Department of Condensed Matter Physics is a Research Infrastructure providing open access to a unique portfolio of instruments needed for up-to-date investigation of physical properties of materials. To assure experiments with well-defined samples of studied materials MLTL include a technology laboratory offering controlled preparation and detailed characterization of sample for measurements. A rich palette of single-crystal growth methods is available. Individual experimental methods used are mastered by highly qualified researchers/teachers engaged in MLTL.

EXPERTISE

A broad spectrum of investigations of crystal structure, magnetic, dielectric, magnetoelectric, electrical- and thermal-transport, thermal and bonding properties of materials in wide ranges of temperature, magnetic and electrical field, and external pressure can be done. Experiments performed in MLTL are dedicated to investigation of various aspects of magnetism and superconductivity in strongly correlated electron systems, key phenomena in magnetocalorics, multiferroics, magnetic semiconductors, topological insulators and superconductors, magnetism in organic and
inorganic nanomaterials, and numerous other issues of physics and chemistry of novel functional materials.

**EDUCATION IN RESEARCH**

MLTL activities focus on education of young scientific generation. The MLTL involved academics teach in BSc., Mgr. and PhD. courses and supervise students’ theses on subjects connected to research projects pursued in MLTL. Students from foreign universities often come and join this process. The best students and postdocs participate on operation of instruments and introducing newcomers. Advanced education of students in research is the main objective of weekly meetings dedicated to intensive discussions of latest results by the MLTL involved students and academics. The discussions often initiate upgrades of MLTL instruments.

**USER PROGRAM**

MLTL is dedicated to assisting users to make the most of its facilities. Open access to instruments is provided free of charge for proposers of accepted experiments. Proposals for experiments in MLTL can be submitted anytime via USER PORTAL of [http://mltl.eu/](http://mltl.eu/). Local Contacts representing MLTL are ready to assist proposers during submission process. The submitted proposals are continuously reviewed by the MLTL Panel on the basis of scientific merit and quality of up to know published results from previous experiments performed by the proposer and his team in MLTL. These criteria are adopted in order to achieve scientific excellence on an international scale. Students’ proposals for experiments needed for completing theses are favored. Decision on acceptance of the proposal are made by the MLTL Panel within 2 weeks after submission. The users’ experiments are assisted by Local Contacts who provide technical and also scientific support.

**KEY RESEARCH EQUIPMENT**

**MEASUREMENTS OF PHYSICAL PROPERTIES**

A suite of 5 major versatile instruments (*PPMS 14T* and *PPMS 9T* – Physical Property Measurement Systems, *MPMS XL 7T* - Magnetic Property Measurement System, *20 T and 9 T cryomagnets* equipped with *³He/⁴He dilution refrigerator*) enable measurements of magnetization, magnetic susceptibility, heat capacity, electrical resistivity, magnetoresistance, Hall resistivity, thermal conductivity, Seebeck effect, thermal expansion, magnetostriction, electrical capacity and permittivity within wide ranges of temperature (30 mK – 1000 K), magnetic field (0 – 20 T), voltage (- 50V – 50 V), external pressure (up to 25 GPa). In PPMS 14 T unique measurements of Raman spectroscopy and Scanning Probe Microscopies (AFM, MFM, etc.) are implemented.

**TECHNOLOGY OF MATERIALS**

Two *Solid State Electrotransport (SSE) instruments* are used for purifying elemental metals (Rare earth metals and uranium) as well as refining single crystals of intermetallic compounds.
Arc furnace - is used for the synthesis of polycrystalline samples. Splat cooling system enables synthesis of micrograin materials and high-temperature crystalline phases metastable at room temperature.

Several instruments are dedicated to growth of high quality single crystals:

- Tri-arc furnace enabling application of Czochralski method.
- Optical 4-mirror furnace offering the floating zone method.
- Multipurpose high frequency induction furnace enabling e.g. growth of single crystals in sealed Mo or W crucibles by Bridgeman method.

Basic characterization and orientation of single crystals is accomplished with a Photon Laue diffractometer.

PARTNERSHIPS AND COLLABORATIONS

The strategic objective of MLTL is scientific excellence on international scale. The key aspects are: openness to international community, collaboration with world leading laboratories and outstanding researchers, continuous staff education, training of young scientific generation, upgrading instruments in response to users’ needs, promoting high standard publication and presentation of obtained results.

ACADEMIC PARTNERS

- Institute of Physics, Czech Academy of Sciences, Prague, Czech Republic
- Institut Laue Langevin, Grenoble, France
- European Spallation Source ERIC, Lund, Sweden
- European High Magnetic Field Laboratory, Dresden, Germany
- Universität zu Köln, Germany
- Institut NÉEL CNRS, Grenoble, France
- Technische Universität Wien, Austria
- Universidade de Lisboa, Portugal
- P.J.Šafárik University, Kosice, Slovakia
- Tohoku University, Sendai, Japan
- Hokkaido University, Sapporo, Japan

INDUSTRIAL PARTNERS

- Vakuum Praha s.r.o., Czech Republic
- Dicont a.s., Czech Republic
- Foton s.r.o., Czech Republic
- Clasic s.r.o., Czech Republic
- Added Value Industrial Solutions, Eibar, Spain

To define suitable preparation recipe of a novel material information on phase diagrams is highly desirable. To determine key ingredients of so far unknown phase diagrams, namely parameters of phase transformations, the SETSYS Evolution TGA-DTA/DSC is frequently used in MLTL.

For composition analysis of new samples MLTL has available a SEM Mira 3 - Scanning Electron Microscope equipped by a Bruker EDX detector.

For crystal structure analysis a BRUKER D8 ADVANCE powder diffractometer and a Rigaku R-Axis Rapid single crystal diffractometer are at disposal.