STORAGE RESEARCH INFRASTRUCTURE ECO-SYSTEM

RI Information sheet 2022

CSIC, LowTempLab

Materials

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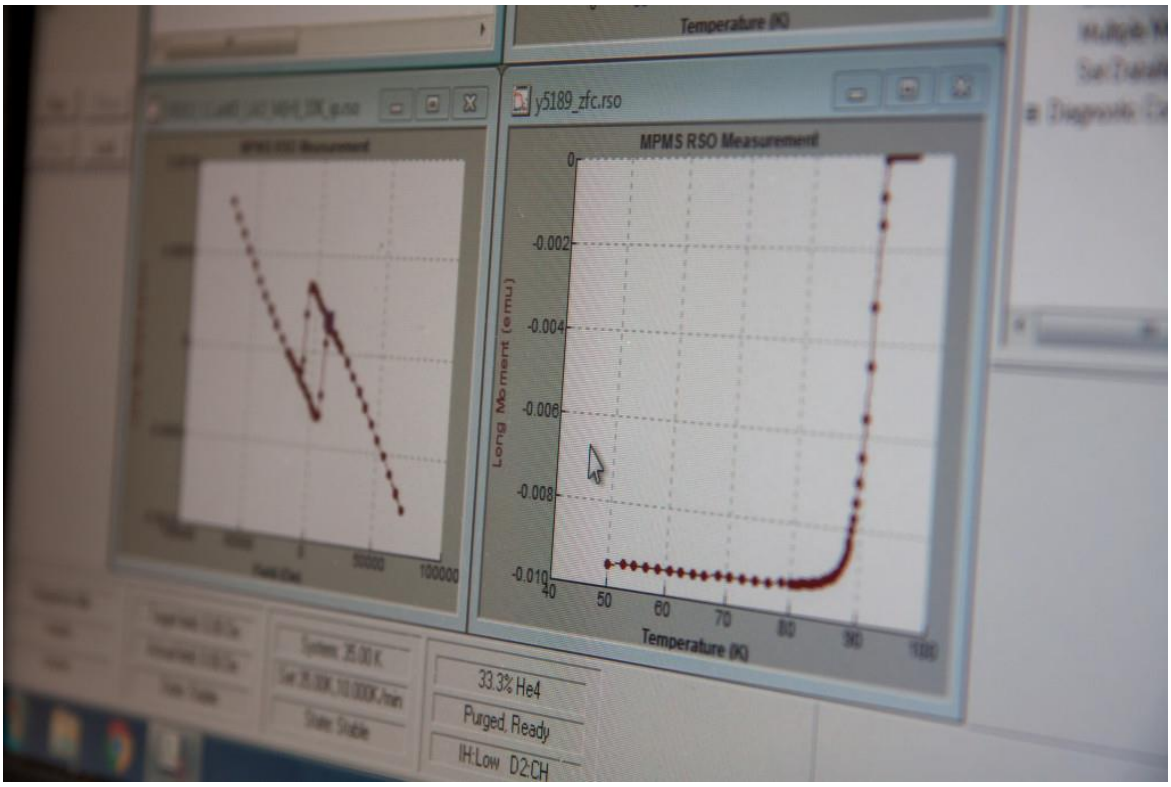
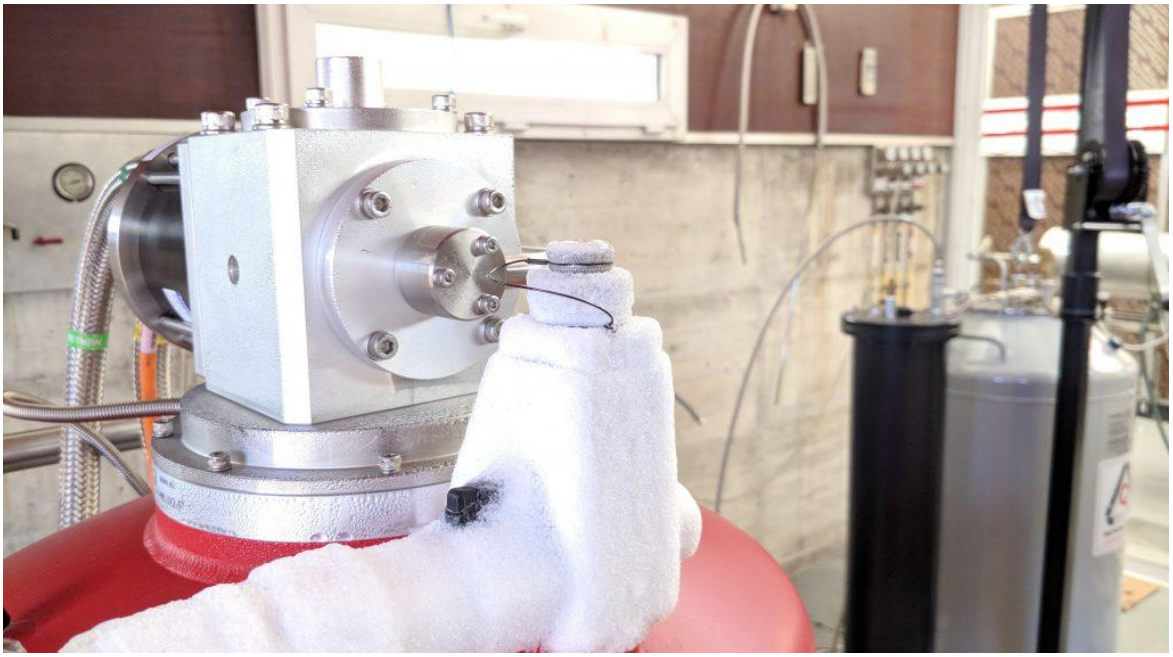
Project Acronym	StoRIES
Call	H2020-LC-GD-2020
Grant Agreement No.	101036910
Project Start Date	01-11-2021
Project End Date	31-10-2025
Duration	48 months

1. Photo





https://icmab.es/ltm

https://services.icmab.es/ltm/

https://icmab.es/research/research-lines

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2. Geographical coordinates

* N 41o 30’ 7.588’’N, 2o 6’ 37.319’’E

*or 41.50210783092121, 2.1103665405313548

* https://icmab.es/ltm

* https://services.icmab.es/ltm/

*https://annualreport2020.icmab.es/institutional-highlights/scientific-technical-services/234-low-temperatures-and-magnetometry-lab

3. Description of the research infrastructure for the webpage

Many investigation lines rely on the magnetic and electric properties of the materials being investigated. Most of the characterization carried out requires the use of very precise measurement systems. In order to satisfy the intensive demand of measurements of this nature, the Low Temperatures and Magnetometry Service was created.

The Low Temperature and Magnetometry Service is part of the ICMAB Scientific Technical Services Unit and its facilities are available to all the research crew of the Institute, as well as, to external users. It is devoted to the measurement of the magnetic, electric properties under specific conditions of external magnetic field and temperature.

Equipment

3.1 Quantum Design MPMS-XL*This magnetometer is based on a SQUID detector that is able to determine extremely low magnetization signals present in the material under study. This magnetization can be evaluated under several conditions of external magnetic field and temperature. The core system consists of a superconducting longitudinal solenoid able to generate magnetic fields up to 70kOe. The system has also able to precisely control the temperature at the sample space at any value from 2K to 400K with a stability condition of less than 0.1% of oscillation.

*Maximum field: ±70kOe
*Temperature range: 2K-400K
*Two measurement modes: DC (continuous sample motion through the picking coils) and RSO (oscillatory motion through the pickup coils)

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Sensivity at zero applied field, magnet in persistent mode: 10-5emu for DC mode, 10-7emu for RSO mode

*UItra-Low field option: Useful for ensuring real zero field cooling processes, since the option is able to cancel the magnetic field at a specified working point

3.2 Quantum Design MPMS-3

The MPMS-3 system is the new generation of SQUID detector based magnetometers. It offers an enhanced performance of temperature stabilization, magnetic field stability when compared to those exhibited by the MPMS-XL system. This fact reduces the measurement noise, allowing the acquisition of cleaner measurements for those samples with extremely low magnetic moment. The core system consists of a superconducting longitudinal solenoid able to generate magnetic fields up to 70kOe. The system has also able to precisely control the temperature at the sample space at any value from 2K to 400K with a stability condition of less than 0.1% of oscillation.

*Maximum field: ±70kOe

*Temperature range: 2K-400K

*Two measurement modes: DC (continuous sample motion through the pick-up coils) and VSM (vibration sample motion around the centre of the pick-up coils)

*Sensitivity at low field: 10-7emu for DC mode, 10-8emu for VSM mode

3.3 Quantum Design PPMS System

PPMS System bundles the same core system as the MPMS-XL, except for the SQUID detection system. A pinout system is available instead, thus making it possible to electrically contact the sample under study and measure its transport properties (resistance, Hall effect, magnetoresistance…). The core system makes possible to generate magnetic fields up to 90kOe and to control the sample space temperature to any value between 2K and 400K with a stability condition of less than 0.1% of oscillation. PPMS is not only limited to electrical measurements, since the electrical contacts at the sample chamber can be used as an interface to more sophisticated measurement systems such as a VSM magnetometer, AC Susceptometer, etc.

*Resistivity

PPMS system is bundled with a current source and a voltmeter multiplexed to three channels that can determine the resistance of three samples quasi-simultaneously using four point measurement approach. Switching between one sample and next is done automatically and

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cyclically several times per second. Option can be used for the determination of the resistivity, magnetoresistance and Hall effect of the material under study. Its speficications allow the determination of resistances ranging from mOhm to approximmately 20MOhm. Sample rotator can be used with this option.
Current: 5nA to 5mA. DC current or square wave AC (plus/minus current); Voltage limit: 0.1mV to 95mV; Power limit: 10nW to 1mW.
* AC Transport
AC Transport uses a waveform generator able to produce driving signals that are used by the current source to produce alternating currents. The bundled voltmeter measures the voltage and the measured signal is treated using a Lock-in based software. Hardware is multiplexed to two channels, so that two samples can be measured during the same session.
Related software is prepared for measuring:
Sample resistivity
IV characteristics
Hall effect
Superconducting critical current
Sample rotator can be used with this option.
Specifications:
Amplitude range: 10uA to 2A
Frequency range: 10Hz to 10kHz
Voltmeter scale ranges: 40uV to 5V
* ACMS
With this option, PPMS can be used as a magnetometer. The option hardware provides the possibility to be used as DC extraction magnetometer or an AC Susceptometer.
Specifications:
Driving field amplitude: 0.1Oe to 15Oe
Frequency range: 10Hz to 10kHz
Working temperature range: 2K to 350K
Sensibility of DC extraction: 1e-5 emu
Sensibility of AC susceptibility: 1e-8 emu
*VSM
VSM based magnetometers provide a fast and precise method for the determination of the DC magnetization of a material. An specially built sample holder that contains a heater allows to extend the working temperature up to 1000K.
Specifications:

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Sensibility: 1e-6 emu
Temperature range: 2K to 300K for normal measurements, 300K to 1000K if oven sample holder is used
* Torque
The measurement of the magnetic torque provides an alternate system for determining the sample magnetization. The main purpose of the magnetic torque measurement is to study the mangetic anysotropy of a material.

3.4 Hall Scanning Microscopy and inverse problem solver (77K)
Allows mapping the remnant magnetic field distribution in planar samples and computing the equivalent current density distribution
3.5 Mechanical Characterization with optical Digital Image Correlation (Local measurements) and Strain gauges (Integral measurement) (77K and RT)
3.6 16T magnet with 50mm bore and 1000A DC (available in the second half of 2022)

4. Availability of the research infrastructure
The installation is not available during the standard Holiday periods, when maintenance operations are running or when the maximum occupancy limitation does not allow the entrance in the rooms. A specific calendar should be previously agreed.

Contact to the Service Technicians, Bernat Bozzo (bbozzo@icmab.es) or Ferran Vallès (fvalles@icmab.es) in order to arrange the details of the measurement.

5. Special considerations
Samples should commit the characteristics of the measurement systems. Contact the Technicians for samples manufacturing. Specific experiments should be considered and approved by the service committee.

6. Energy storage technology that can be analysed/studied by using the research infrastructure

- Electrochemical ☐
- Chemical ☐
- Thermal ☐
- Mechanical ☐
- Superconducting Magnetic ☒
- Cross-cutting ☒ (Specifically: ...)

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7. Key words for the webpage
Magnetic characterization of materials for energy
Electrical characterization of materials
Large range characterization of Temperature behaviour of electromagnetic properties of materials.

8. TRL level (if applicable):

- 1-3 ☒
- 4-6 ☐
- Above ☐

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