More than 1000 Physical Property Measurement Systems (PPMS) are installed world wide.

That's because the **PPMS** is a whole lab in one system!

The PPMS is an automated low-temperature measurement system for the determination of material properties like specific heat, magnetic AC and DC susceptibility, thermal expansion and both electrical and thermal transport properties.

All measurements can be done in a wide range of magnetic fields and temperatures, including the millikelvin range. Its advanced expandable design combines many features in one instrument which make the PPMS the most versatile system of its kind.

Quantum Design

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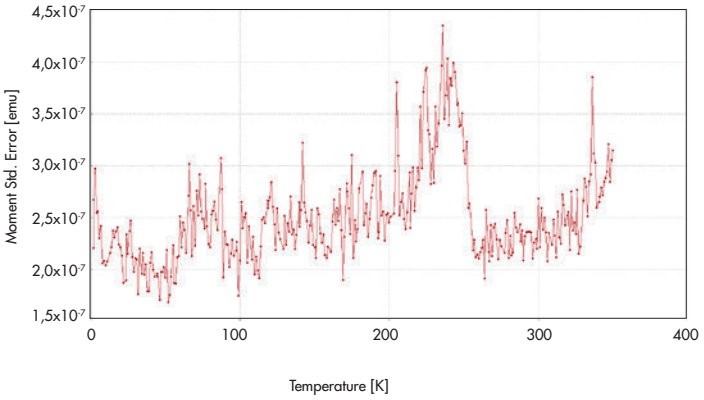
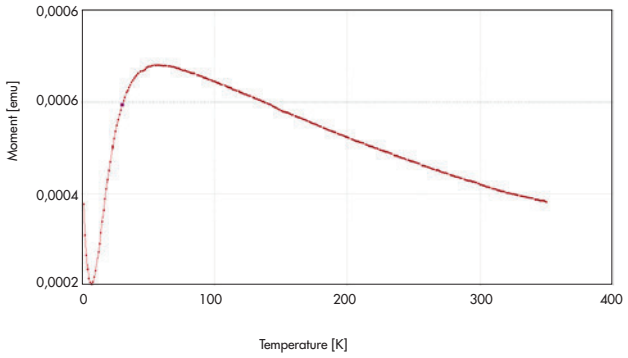
The PPMS series

Magnetic properties

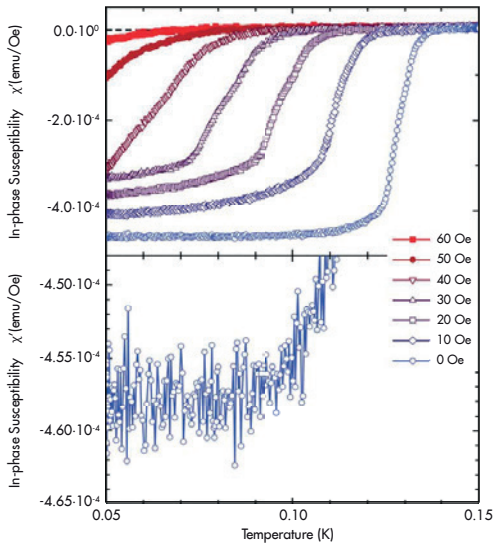
There is a wide variety of options for magnetic measurements for the PPMS. The DC and AC magnetic moment can be measured via a highly sensitive VSM or AC susceptometer. The torque magnetometer reveals magnetic anisotropy with submicrometer emu sensitivity. Photomagnetic properties can be measured using the fiber optic sample holder.
A pressure cell provides high pressure measurements up to the gigapascal range. There also is a special ferromagnetic resonance spectroscopy option that allows broadband FMR characterization with lock-in capability to measure ferromagnetic resonance.





Warming curve of $BiCu_2PO_6$ with 1 T field measured with the VSM. Even when measuring relatively large magnetic moments around $5x10^{-4}$ emu, the noise always stays below $5x\ 10^{-7}$ emu – three orders of magnitude less.

Duration of the measurement averaged 3 seconds; it was taken with 2 mm amplitude in sweep mode with 1 K/min.



In-phase susceptibility for the superconducting transition of an $Ir_{1-x}Ru_x$ sample measured using an AC excitation of 10 mOe and a frequency of 10 kHz for various DC background fields.
The lower graph highlights the noise level for the zero field data.
The peak-to-peak scatter of the data is about $5x10^{-6}$ emu/Oe, corresponding to $5x10^{-8}$ emu in absolute signal.

(Sample provided by Milton S. Torikachvili of San Diego State University)

Properties

- Coercive field
- Remanent magnetization
- Saturation magnetization
- FC, ZFC properties
- Spin glass freezing temperature
- Superconducting transition
- Curie temperature
- Gyromagnetic ratio
- Photomagnetic properties
- Magnetic anisotropy
- Grain size distribution
- Quantum oscillation
- Fermi surface
- Free electrons
- Particle size
- Permeability
- Susceptibility
- Intrinsic damping (FMR measurement)

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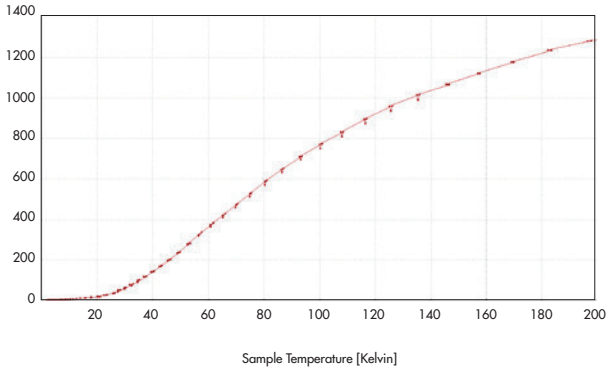
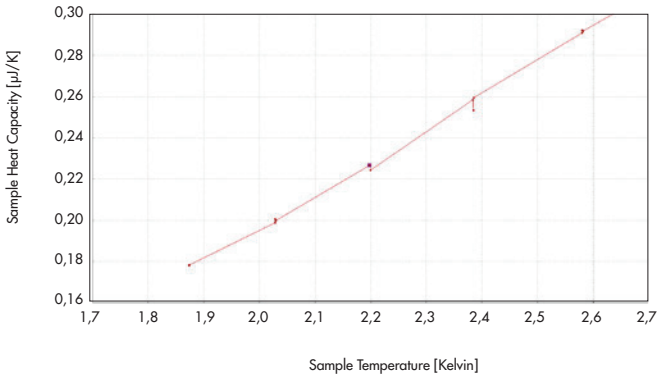
Thermal properties

The PPMS can measure heat capacity with nanojoule sensitivity, thermal conductivity and thermoelectric effects. The measurement of thermal properties is a great way to gain insight into the lattice structure of materials.

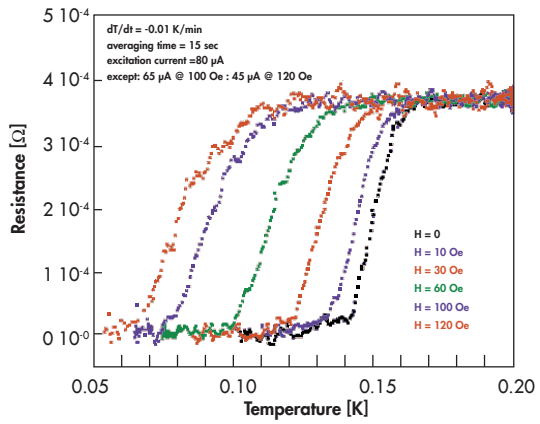




Heat capacity measurement of Al. Three repetitions at each temperature. Deviation of three measurements at 2 K is less than 2 nJ/K peak-to-peak. Step sizes of 20 nJ/K are clearly resolved.

Properties

- Lattice bounding state (2D/3D bound system)
- Debye temperature
- Entropy
- Magnetocaloric effect (MCE)
- Λ-Peaks
- Schottky anomaly
- Seebeck effect
- Thermoelectric figure of merit (ZT)
- Ettinghausen-Nernst effect



AC magnetic moment of a GGG sample. The plot shows that the measurements during cool down and warm up have two identical curves. At 100 K the signal is around 1.75 10^{-4} emu with 7x10^{-8} emu noise. The measurement was taken at 4000 Hz.

Electrical properties

The PPMS covers a huge resistivity range for electric measurements from nano-ohms to giga-ohms. A rotating platform allows anisotropy measurements. Individual measurement setups can be implemented by using a multi-function probe. The system features a pressure cell for high-pressure measurements.

Properties

- Carrier density
- Carrier mobility
- Carrier type (n- or p-type)
- 2-4 wire resistance
- Differential resistance
- Schottky barrier
- Photo resistivity
- Giant magneto resistance (GMR)
- Spin density wave (SDW) characteristic step
- Fermi surface
- Superconducting transition

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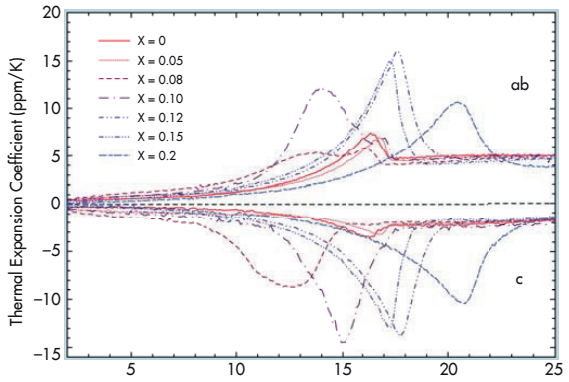
Mechanical properties

The dilatometer option enables measurements of the relative expansion (dilation) and first derivative (coefficient of expansion) with respect to temperature and field and sub-angstrom sensitivity.

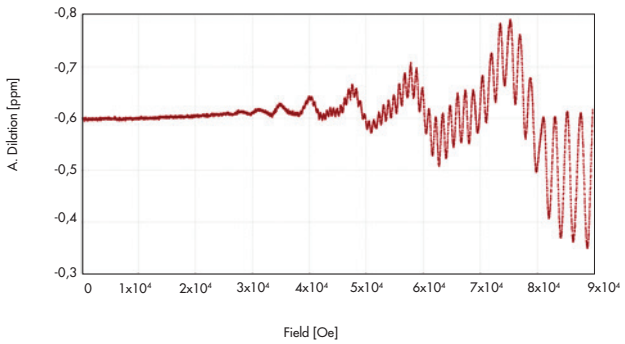


Thermal Expansion Measurements of URu_2-x$FexSi_2$

(Department of Physics, University of California, San Diego, USA)

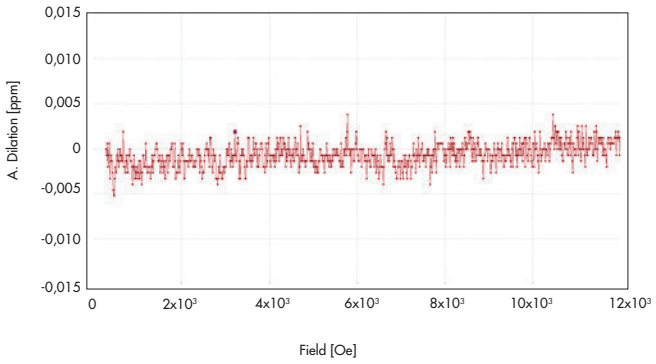
Properties

» Thermal expansion coefficient
» Magnetostriction



Most common applications

- Topological insulators
- Spintronic materials
- GMR materials
- Graphene
- Semiconductors
- Superconductors
- Rare earth magnets
- Molecular magnets
- Magnetic nanopowders
- Multiferroics
- Magnetocaloric materials
- Heavy fermion systems
- Functional oxides
- Heusler alloys
- Thin films



Magnetostriction measurement of Al at 10 K with 0 – 9 Tesla field. Noise is less than 5 ppb over the full field range.

By the way...
More than 28.000 scientific publications explicitly refer to measurements performed with the PPMS.

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