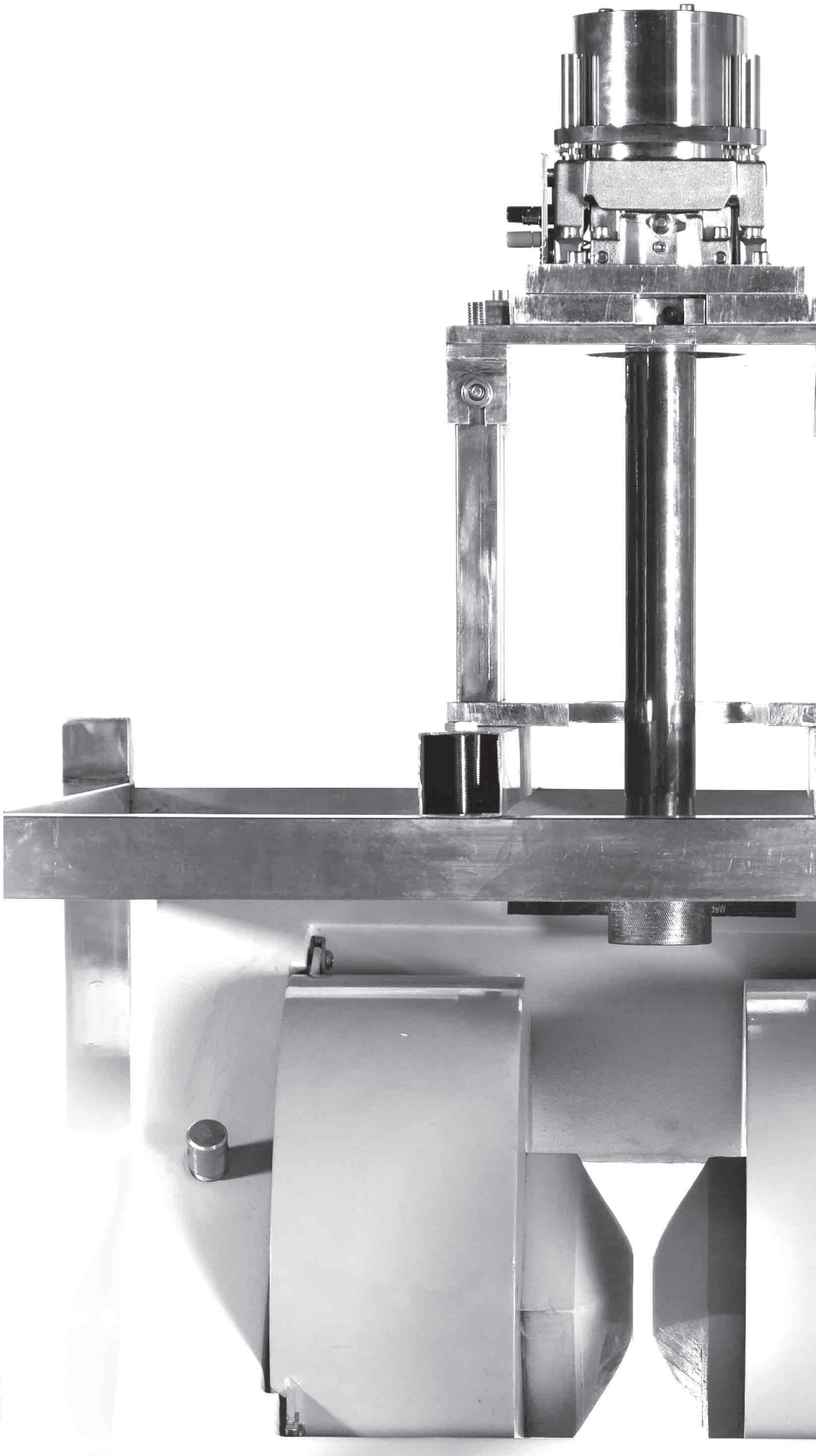
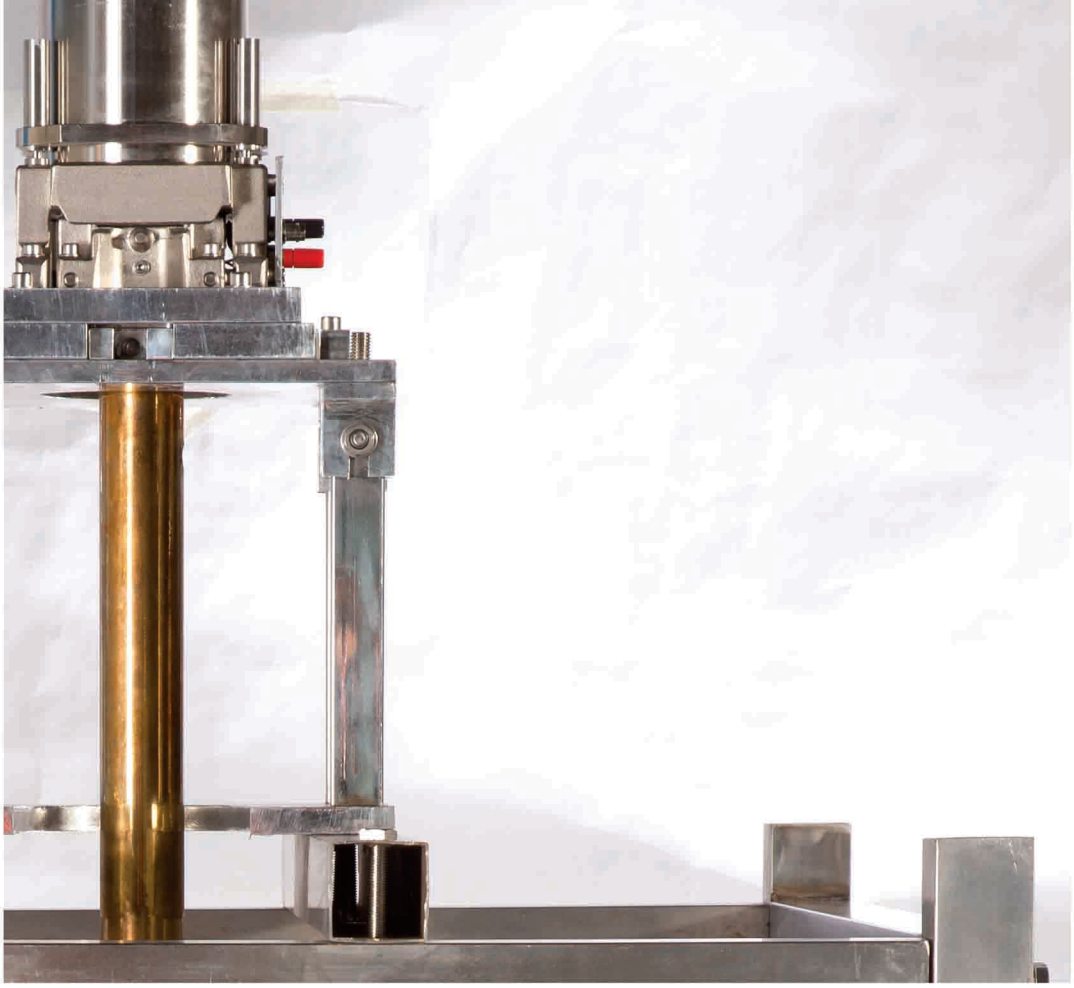


VIBRATING SAMPLE MAGNETOMETER



Virtually any type of magnetic material can be characterized on the MDK-VSM systems. Solids, liquids, powders, thin films, rocks etc. are all common applications for the MDK-VSM systems.
Due to a proprietary real-time field control system, MDK-VSM is suited for measuring samples with extremely low magnetic signals and/or very low coercivities. This system is one of the most compact electromagnet based VSM that can reach a maximum field of 2T with the temperature option.
The MDK-VSM Series supports all known types of magnetic measurements such as hysteresis and minor loops, IRM and DCD remanence loops, SFD, delta M, delta H and Henkel plots, as well as angular and AC remanence loops, temperature scans and time decay measurements.
The electromagnet field control platform (FCP) integrates hardware and firmware components to form a variable magnetic field platform that can be utilized independently or as the foundation for a user-designed magnetic measurement system.
The FCPs include a MDK electro-magnet, a bipolar magnet power supply, a DSP gaussmeter with integrated field control firmware, and a gaussmeter Hall probe and holder.

Thin film Alternating Gradient Field Magnetometers (AGFM) have potential for measuring magnetic moments of minerals in extraterrestrial soil samples. AGFM sensors offer increased spatial resolution required to detect magnetic nanoparticles for biosensing applications. We have fabricated a patterned thin film with the properties necessary for use in a small AGFM system.
AGFMs are fundamental instruments for characterizing magnetic materials. This type of magnetometer is extensively used in both laboratories and production environments for measuring the basic magnetic properties of materials as functions of magnetic field and, if desired, temperature. The AGFM is well known because of its high sensitivity and low noise floor. Due to its features, the AGFM can be used for characterizing the magnetic and mechanical properties of MNPs.

company HISTORY

time line

Foundation in 2006

Improvement & Increasing at Vibrator Frequency in 2009

High temperature in 2012

VSM Design & in 2007 Manufacture

AGFM in 2010

FORC in 2011

Advantages

- Continuously adjustable poles allow rapid air gap changes to suit individual experiments, assuring magnet versatility
- Exceptional field intensities achieved with cylindrical or tapered pole caps
- Water-cooled coils provide excellent field stability and uniformity
- Removable pole caps facilitate variable pole face configurations and easy pole cap exchange
- Accurate pole alignment by precise construction of the air gap adjustment mechanism
- Compact size of the EM4 permits convenient bench-top mounting
- Optional optical access pole caps available
- Magnetic property in nanomaterials

Magnetic nanostructured materials, whereas their components have at least one dimension below 100 nm, are important to both theoretical and experimental studies. Magnetic nanowires, i.e. materials with two dimensions at nanometer scale, in particular are commonly studied as an array of nanowires fabricated by depositing magnetic material into a nanoporous template. Materials such as track-etched polymers and anodic porous alumina allow for uniform control of nanowires. Consequently, the interaction properties of the magnetic nanowires greatly depend on the quality of the template used. The First Order Reversal Curve (FORC) method probes the interior of the major hysteresis loop and it was shown that has the ability to reveal the interactions within the system. When running a FORC experiment it is imperative to ensure that the noise from the measurement it at a minimum. Using material that exhibits a strong ferromagnetic signal, increasing the averaging time between data points, and eliminating most of the material that can give undesirable signals (i.e., substrates, capsules, sample contamination, and so on…) are a few precautionary steps to aid in obtaining excellent FORC measurement results.

The FORC method in not only a tool with qualitative analysis capabilities, it allows for a quantitative analysis approach by capturing the distribution of magnetic properties. It is helpful to apply a coordinate change to the FORC distribution for the discussion of the magnetic properties. This is done by considering a hysteron in terms of local coercivity and biasing fields, which affect wideness of the loop and how much the loop is shifted horizontally, respectively.

Features

Noise below 0.5 μemu when used with temperature option
Noise below 0.1 μemu at a usable sample space
Field noise <5mOe
Highest magnetic field of >1.75T with temperature chamber in place of any similarly sized system
No hardware change between cooling and heating from 298K to 873K
Safe and reliable water-cooled magnet power supply
The MDK-VSM capable use in characterization for all types of magnetic materials:
Diamagnetic, Paramagnetic, Ferromagnetic, Ferri magnetic, Antiferromagnetic materials and
Anisotropic materials
Particulate and continuous magnetic recording materials and GMR, CMR, exchange biased and spin-valve materials
Magnetic-optical materials
Bulk materials, powders, thin films and single crystals are readily accommodated

Specifications

Electromagnet
With sample space of 20mm: 2.0T
Dynamic range: 0.1 μemu – 100 emu (extendable to 1000 emu)
Accuracy: ± 1% + noise if sample and calibration standard are equal in shape and size.
Field Stability: Better than 1% of reading ±0.05% of full scale
Cooling water requirements: Tap water or closed cooling system (optional chiller available) +11 °C to +25 °C
Flow rate: 10 L/min
Magnet power supply
Maximum output:
Voltage: up to 50 V
Current: up to 150 A
Power: up to 7.5 kW

Hall Probe Accuracy: 0.5 Oe

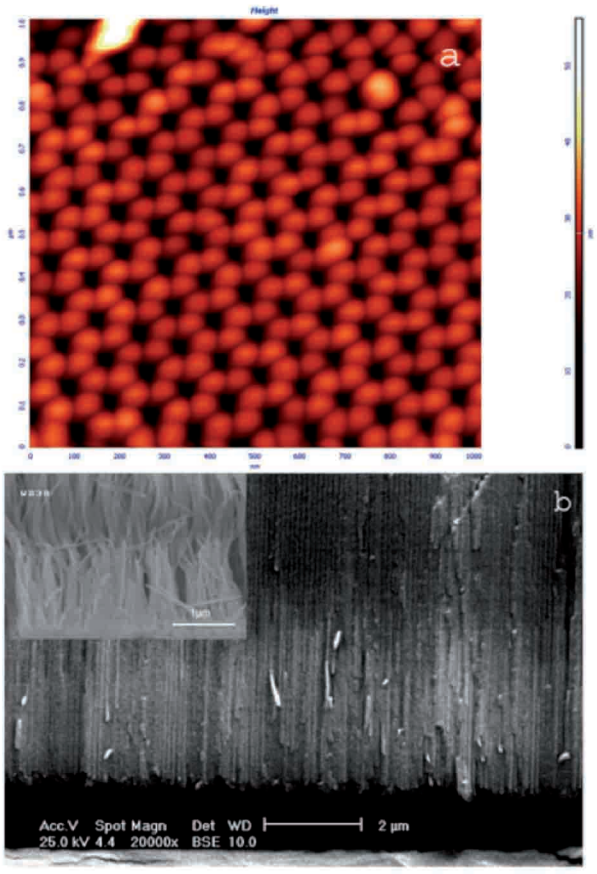
Argon High temperature system
Range: 298K - 873K
Resolution: 0.01K
Inside diameter: 10 mm

Applications
Magneto-optical media development
Spin Valves
High temperature superconductors
Amorphous metals
Particulate and plated films
Multi-layer thin film
Diamagnetic & paramagnetic materials
Pure R&D/QC applications
Rare earth materials analysis
Time dependence
Magnetic anisotropy measurements
Ferrofluids
Giant Magnetoresistors (GMR) studies
Magnetoresistive random-access memory (MRAM)
Nanotube technology
Magnetic nanoparticles

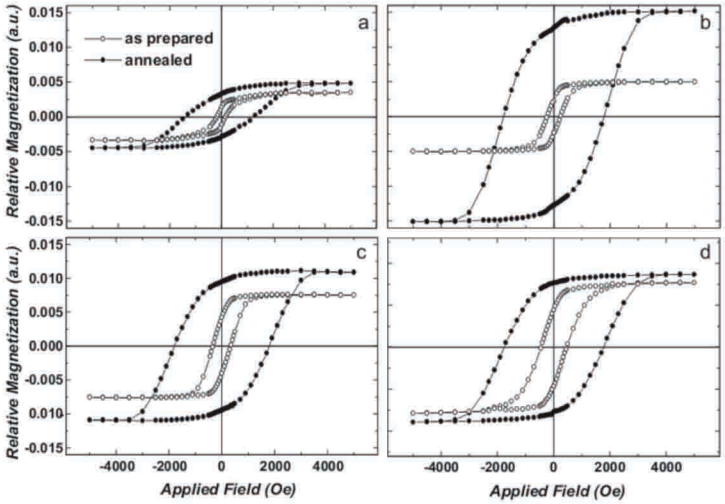
outlined OUTCOMES

CoZn alloy nanowire arrays embedded in anodic aluminum oxide (AAO) template were fabricated byalternative current (AC) pulse electrodeposition. Various off times between pulses in an electrolyte withconstant concentration of Co+2and Zn+2and acidity of 4 were employed. The effect of deposition parameters on the alloy contents, microstructures and magnetic properties of CoxZn1−x nanowires were studied.It is shown that, Co content increased by increasing the off time between pulses. This phenomenonenables us to fabricate Zn and Co-rich nanowires by adjusting the off time during the deposition procedure. Increasing the off time more than 200ms increased the coercivity and squareness of CoZn nanowirearrays. A significantincrease in the coercivity of CoZn nanowires was observed after annealing which wasvaried for the samples fabricated with different electrodeposition conditions. A coercivity of 1785 Oe wasobtained for the annealed sample (a sample fabricated with 50ms off time) from initially 240 Oe.

Magnetic properties improvement through off time between pulses andannealing in pulse electrodeposited CoZn nanowires
Journal of Alloys and Compounds 509 (2011) 8845–884



(a) A top view AFM image of the nanopore arrays prepared by the two stepanodization method for 2h and (b) a cross section SEM micrograph of Co0.8Zn0.2nanowire arrays prepared with an effective electrodeposition time of 1 min. A crosssection view of nanowires after removing of alumina template is inserted.

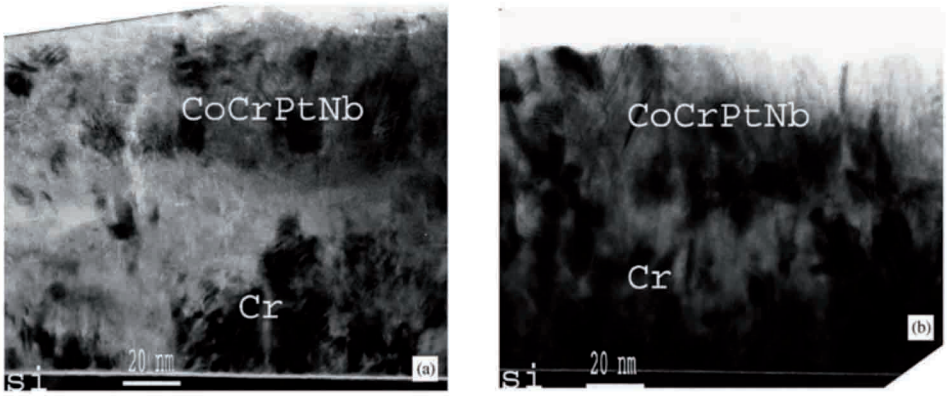


Hysteresis loops of both the as prepared samples and annealed ones synthesized at (a) 10, (b) 50, (c) 400 and (d) 600 ms off times.

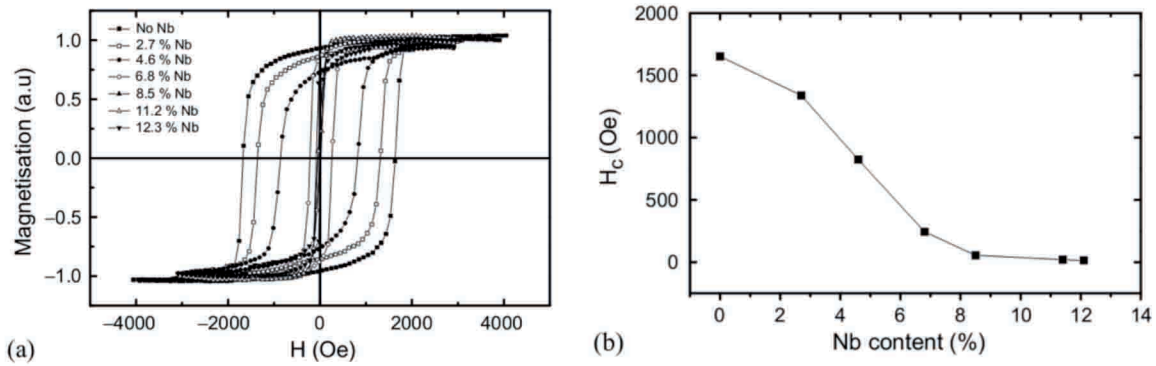
outlined
OUTCOMES

Quaternary (CoCrPt)100-xNbx/Cr bilayer thin films have been sputter-deposited and their magnetic and microstructural properties determined as a function of niobium content and thermal annealing. Coercivity, magnetisation, crystallography and magnetic interactions are shown to be dependent on composition and annealing conditions. Large coercivity increases and reduced magnetisations and intergranular interactions are obtained in annealed crystalline samples. As-deposited amorphous samples and those crystallised during annealing exhibit low coercivity. The observed properties are explained in terms of composition and crystallographic orientation on deposition and by a redistribution, diffusion and oxidation of elements on annealing.

The magnetic and microstructural properties of sputter-deposited and annealed CoCrPtNb thin films
Journal of Magnetism and Magnetic Materials 248 (2002) 190–199



Cross-sectional TEM micrographs of the (a) as-depos-ited and (b) annealed samples containing 2.7% Nb.



Hysteresis loops (a), coercivity values (b) and MSt values