Policies and Procedures

NNF/NCMN Acknowledgements in Publications

The research was performed in part in the Nebraska Nanoscale Facility: National Nanotechnology Coordinated Infrastructure and the Nebraska Center for Materials and Nanoscience, which are supported by the National Science Foundation under Award ECCS: 1542182, and the Nebraska Research Initiative.

[This is required by the NSF and UNL Administration.]

Staff Co-Authorship on Publications

Co-authorship on publications for NCMN staff may be considered appropriate when they have provided one or more of the following:

- Significant intellectual contribution to the design of the published experiments;
- Substantial practical contribution to the generation, analysis and/or interpretation of experimental data;
- Indispensable technical support that contributed intellectually or scientifically to the advancement of the work.

Nebraska Center for Materials and Nanoscience

CENTRAL FACILITIES

Policies and Procedures

NCMN
Nebraska Center for Materials and Nanoscience
University of Nebraska

Version 3.0

Effective Sept. 2016

Nebraska Center for Materials and Nanoscience

The Nebraska Center for Materials and Nanoscience (NCMN) was founded by the Board of Regents in 1988 to serve as the focal point of interdisciplinary research in materials in the College of Arts and Sciences and College of Engineering. The overall goal of NCMN is to provide for the State of Nebraska and the University of Nebraska a nationally recognized center of excellence in materials research science and engineering, nanoscience, and nanotechnology. In 1988 there were about 40 faculty in NCMN with about $1.0 million in annual research expenditures. By 2013 these numbers had grown to about 80 and $20 million, respectively. This huge growth in external research funding and the related graduate education is the most notable achievement of NCMN faculty.

The Center is strengthened by a rather broad research purview, with participation by a wide variety of faculty from UNL Chemical & Biomolecular Engineering, Chemistry, Electrical Engineering, Mechanical and Materials Engineering, Physics, UNO Chemistry, UNO Physics, UNMC, and UNK Chemistry. On average, about 70% of the total external funding obtained in the participating departments is associated with NCMN faculty. Since 1988 some 34 materials research faculty have been hired, many of them receiving significant setup funding from NCMN. At present about 142 graduate students, 20 undergraduate students, 20 postdocs or visiting scientists, and 10 technical staff are involved in research in the Center.

Mission, Objectives and Goals

General goals of NCMN are to: perform and publish world-class research; educate students in the relevant scientific and engineering disciplines; promote interdisciplinary group and single-investigator grants to improve the university's national research competitiveness; and to contribute to the economic development of Nebraska through industrial collaborations, spin-offs, materials analyses, and tech transfer to companies.

The Central Facilities of NCMN are a significant and essential component of the research activities in materials and nanoscience at this University. The large research enterprise including the national NSF-supported Nebraska Nanoscale Facility (NNF): National Nanotechnology Coordinated Infrastructure (NNCI), Materials Research Science and Engineering Center (MRSEC), the Voelte-Keegan Nanoscience Research Facility and others are highly dependent for their operation on NCMN and its Core Facilities.

The Nanoscale Science and Technology (NST) Program of Excellence (POE) is administered by NCMN, whose research portfolio includes nanoscale materials science and technology, and whose Core Facilities significantly enable NST research. The NCMN faculty include over 25 distinguished professors. NCMN has an Advisory Committee of 8 professors from the participating departments that provides guidance on the operation of the POE, of course in collaboration with department chairs and deans.

The *current focus* of NCMN is centered around faculty development and hires in several departments, utilizing fully the Voelte-Keegan Nanoscience Center, development of interdisciplinary courses in materials, nanoscience and nanotechnology, and continuing the growth of research funding and outreach at UNL and Nebraska.

For corrections or questions on this brochure contact NCMN through http://ncmn.unl.edu/.

David J. Sellmyer
George Holmes University Professor and

Director, NCMN

Policy Statement

The specific aims of the NCMN are to: perform and publish world-class research; educate students in the relevant scientific and engineering disciplines; promote interdisciplinary group and single-investigator grants to improve the university's national research competitiveness; and to contribute to the economic development of Nebraska through industrial collaborations. To accomplish these goals, the NCMN operates and coordinates six Central Facilities that are open to all UNL researchers as well as external (private sector) researchers. The operation shall be conducted in compliance with University of Nebraska regulations, applicable federal, state, local regulations, University Health and Safety requirements and standards. User fees are charged to all users to offset the costs incurred in providing scientific equipment and technical expertise.

Reason for Policy

The NCMN provides its Central Facilities with consistent operational practices to ensure compliance with applicable federal, state, local regulations, University Health and Safety requirements and standards.

Who Should Read This Policy

NCMN Facility Staff and Administrators
NCMN Facilities Users
NNF:NNCI Facilities Users

Acknowledgement Policy

University, NCMN, and NNF:NNCI policy requires users to acknowledge support from NNF and NCMN in publications performed in part in its Central Facilities. An example of such an acknowledgement is as follows "This work was performed in part in Nebraska Nanoscale Facility: National Nanotechnology Coordinated Infrastructure and the Nebraska Center for Materials and Nanoscience which is supported by the National Science Foundation under award ECCS: 154182 and the Nebraska Research Initiative."

Related Documents

U.S. Federal Government, Office of Management and Budget (OMB)

- OMB Circular A-21: Cost Principles for Educational Institutions
  www.whitehouse.gov/omb/circulars_a021_2004

- OMB Circular A-110: Uniform Administrative Requirements for Grants and Agreements with Institutions of Higher Education
  www.whitehouse.gov/omb/circulars_a110

National Science Foundation

- NSF Grant Policy Manual
  www.nsf.gov/publications/pub_summ.jsp?ods_key=papp

University of Nebraska

- UNL Environmental Policy
  http://ehs.unl.edu/policystatements/EnvironmentalPolicy.pdf

- Board of Regents Safety Policy
  http://ehs.unl.edu/documents/safetypolicy.pdf

- UNL Policy on Distribution of F&A Cost at UNL
  http://research.unl.edu/sp1/policies.shtml

- UNL Conflict of Interest in Research Policy
  http://research.unl.edu/orr/docs/UNL%20Conflict%20of%20Interest%20in%20Research%20Policy.pdf

- University of Nebraska Board of Regents Policies
  http://nebraska.edu/docs/board/RegentPolicies.pdf#page=1

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Introduction

Materials and nanoscience stands as a basis for modern technology, with important applications in advanced electronics, sustainable and clean sources of energy, transportation and building materials, and health care. The capabilities of NCMN and its Central Facilities in the Voelte-Keegan Nanoscience Research Center are critical to the University's mission in research, education and impact. Important focus areas of NCMN research include: Nanomaterials, nanobonding, nanostructuring; Nanomodeling, theory and simulation; Nanomagnetism, spintronics and nanoferroics; Quantum and molecular materials and devices; Nanophotonics; Nanomanufacturing; and Nanoscale characterization and metrology.

In support of these goals, NCMN operates six Central Facilities:

- Cryogenics Instrumentation Facility
- Electron Nanoscopy Instrumentation Facility
- Nanofabrication Cleanroom Facility
- Nanomaterials and Thin Films Facility
- Surface and Materials Characterization Facility
- X-Ray Structural Characterization Facility

A brief introduction to each Facility will be given at the end of this booklet and a more detailed description and capabilities of each facility can be found on the NCMN website.

Use of the Facilities

The NCMN Central Facilities are open to all qualified researchers at UNL, at other universities and in industrial and other laboratories on payment of the appropriate charges.

All users are required to obtain appropriate training and instruction specific for each instrument from the Facility Specialist. Users must demonstrate sufficient proficiency before and during equipment usage for training to be completed. Most instruments require reservation in advance of use. In the unlikely event that equipment is simultaneously needed by more than one researcher, members of the UNL community receive priority. In the event of a temporary closure, the Facility Specialist will provide timely notification whenever possible.

All users are required to take all appropriate safety training from the University Environmental Health and Safety (EHS). The EHS requires basic Laboratory Safety training consisting of a Core Safety Orientation, Core - Injury and Illness Prevention Plan (IIPP), and Core - Emergency Preparedness Training. In addition to the basic safety training each facility may require further safety training such as X-Ray Safety Training is required to use the X-Ray Characterization Facility.

In general, facilities are open at all times to qualified users but due to specific technical complexities associated with safe operation of equipment, access to the facilities outside normal working hours is limited to trained and experienced or expert users only and is at the discretion of the Facility Specialist. Expert users are those that have demonstrated the ability to operate the equipment alone without seeking help from the specialist and who has successfully used a particular instrument at least 5 times without causing any issues and has obtained permission from the specialist to make specific hardware changes, if applicable, by strictly following instructions obtained from the specialist.

Technical support by the specialist is available during normal hours on work days. If a life threatening emergency arises beyond these hours, the user should dial 911 immediately. In the event of a non-life threatening emergency or any instrument related issues the user may call /text/email the specialist to report the issue and seek opinion.

On a multifunctional instrument, any user (expert / non-expert) is allowed to perform only the applications that he/she is trained on. The allowed hardware changes permissible to expert users are at the specialist's discretion. Apart from usual wear and tear and accidents, the responsibility of damage caused by user negligence will be borne by the principal investigator. Prior to working late hours, the users shall obtain the consent from their faculty advisor.

University, NCMN, and NNF:NNCI policy requires users to acknowledge support from NNF and NCMN in publications performed in part in its Central Facilities. An example of such an acknowledgement is as follows "This work was performed in part in Nebraska Nanoscale Facility: National Nanotechnology Coordinated Infrastructure and the Nebraska Center for Materials and Nanoscience which is supported by the National Science Foundation under award ECCS: 154182 and the Nebraska Research Initiative."

Commercial Use of the Facilities

UNL and NCMN policy supports and encourages the collaboration between universities, industrial and manufacturing sectors. These collaborations should promote a more rapid development of research and the dissemination of knowledge and will contribute to Nebraska's economic development through the development of new products and devices, spin-offs, and tech transfer to companies. The university and NCMN encourage its researchers and facilities to forge interdisciplinary partnerships with industry.

Facilities must conform to the requirements stated in the relevant policies from the Federal Government, NSF and UNL:

1. Commercial use of the facility must not interfere with the research mission of the NCMN.
2. Appropriate fees must be charged to recover full costs.
3. Fees for services to commercial businesses must not be less than fees charged for equivalent services from viable commercial vendors or facilities.

User Fees

- All users shall pay user fees.
- Fees charged to academic users are based on a cost-recovery principle.
- For-profit enterprises must pay the full cost of using facility resources. In addition, facilities may not directly compete with services provided by private companies in a manner that is prohibited by OMB Circular A- 110.
- Facility specialist labor charges only cover direct services such as specimen preparation, instrument or equipment set-up, training of new users, and data gathering and analysis.
- Routine maintenance of instruments is not a direct service. Minor consultation on experimental techniques or simple instruction on the use of equipment is also not considered to be a direct service.
- Materials consumed during the normal operation of NCMN instruments are normally included in user fees and not billed separately. In order to keep hourly charge rates low in some cases, users are charged and billed at cost for supplies (e.g., AFM tips). User specific materials such as substrates and deposition materials are in general not provided by the NCMN and must be obtained by the user.
- On request, estimates can be made by a Facility Specialist for a project based on prior experience with the understanding that the quotation is subject to inaccuracy. The Facility will not be held responsible for any unforeseen circumstances that do not permit the work to be completed within the estimated cost or time schedule. All work is subject to equipment availability.
- Current rates shall be posted on the NCMN Facilities websites.
- User fees in each facility shall be reviewed bi-annually or more frequently if required.

Reserving Time on Facility Equipment

Most of the facility equipment requires reserving time in advance. Users who have completed training will be given a user account for the Online Instrument Sign-up Calendar. The Online Instrument Sign-up Calendar website can be reached at: http://ncmn.calendarhost.com/cgi-bin/calweb/calweb.cgi.

Reservations are on first-come first-served basis. Users are expected to reserve only the time they need and to be respectful of needs of other users. In addition, users are responsible for the time they have reserved and can be charged for unused time if they fail to cancel at least 12 hours in advance of the scheduled time.

Facility specialists reserve the right to reschedule or cancel reservations.

Environmental Health and Safety

A priority of the NCMN Central Facilities is to maintain a safe working environment. All NCMN staff and users shall conduct operations in compliance with all applicable federal, state, local regulations, and university policies including all University Health and Safety requirements and standards. All NCMN staff and users shall obtain and maintain all required EHS safety training. The facilities strive to maintain a safe working environment by keeping all the equipment and work places well kept. Users are expected to clean up after themselves. All staff and users shall conduct safety self-audits to identify non-compliance items and take corrective measures.

NCMN Facility Management

The overall management of the NCMN Facilities is the responsibility of the NCMN Director. Each NCMN Facility has a Facility Specialist who reports to the NCMN Director and manages the daily operation of the Facility. Also each Facility has at least one Faculty Advisor appointed by the NCMN Director.

Duties of NCMN Director

1. Supervise the general operations of the NCMN Central Facilities.
2. Establish suitable policies for the NCMN Facilities and to ensure those policies comply with university, state and federal governmental policies.
3. Hire and supervise facility staff.
4. Conduct periodic reviews of facility operations, activities and financial status.
5. Manage the approval of special requests and waivers.

Duties of Facility Specialists

1. Manage the day-to-day operation of facility and maintain the facility instruments.
2. Train and supervise facility users.
3. Coordinate and provide expert technical input on the acquisition and installation of new instrumentation.
4. Remain current on research that utilizes techniques provided by the facility.
5. Establish safety practices and policies for the facility

Duties of Faculty Advisor

1. Support the acquisition process of new equipment by collaborating on the preparation and submission of internal and external proposals.
2. Provide technical advice regarding facility operation and resources.
3. Provide expert advice in the annual update of the facilities.

Enforcement of This Policy

Any NCMN facility user who violates this policy or any policy referred herein will be reported to the NCMN director. At his discretion, the NCMN director may suspend an offending user's access to equipment or facilities for a limited or extended period of time.

NCMN Cryogenics Instrumentation Central Facility

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Function

The Cryogenics Instrumentation Facility (CIF) provides the means for obtaining liquid Nitrogen and liquid Helium for low temperature research, cold traps, etc.

Liquid Nitrogen: A 230 liter supply of liquid Nitrogen is maintained at this facility. Researchers can transfer LN2 to their own dewars (typically 1-30 L) as needed and are billed on a per liter basis.

Liquid Helium: Liquid He orders are delivered to UNL only once a week (Tuesdays) and orders must be submitted to the specialist by the previous Thursday to ensure that the request is placed in time. A delivery location (building and room#) should be specified. LHe can be ordered in 60 or 100 liter containers.

The facility offers equipment for sample characterization and sample modification. The first system is a MPMS XL SQUID magnetometer from Quantum Design. The MPMS Xl uses a Superconducting Quantum Interference Device (SQUID) Magnetometer to monitor very small changes in magnetic flux and to characterize the magnetic properties of samples. The MPMS XL offers a user friendly automated software, a dynamic range in temperature and a sensitivity of 1x10-8 emu. Data can be collected as magnetic moment vs temperature measurement (ZFC-FC, susceptibility) or moment vs magnetic field (hysteresis loops). The system for sample modification is a 4.5 T magnetic annealing system. This system will combine high temperature annealing with a high magnetic field to potentially modify the magnetic properties of thin film and alloys. The system makes use of exchange interactions at high temperature to form new magnetic properties and/or control the crystal growth

NCMN Electron Nanoscopy Instrumentation Central Facility

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Function

The Central Facility for Electron Nanoscopy Instrumentation (ENIF) is a state-of-the-art electron-microscopy facility providing users access to modern transmission and scanning electron microscopes. The function of the Facility is to help researcher produces high quality results by providing hands-on access to electron microscopes, sample preparation equipment plus data-collection and data-reduction instrumentation, along with advice, training and research collaboration. The scope of the Facility is materials characterization of the topography, morphology, elemental composition, crystalline microstructure, crystal defects, and atomic arrangements of materials, largely on a scale from 10 micrometers down to the near-atomic level.

Equipment

The Facility houses three electron microscopes; FEI Tecnai Osiris S/TEM, FEI Nova NanoSEM450, JEOL JEM 2010 TEM, and JEOL JSM 840A SEM.

The Tecnai Osiris™ is a fully digital 200 kV S/TEM system, designed to deliver revolutionary analytical performance and outstanding quality in high resolution TEM and STEM imaging. Tecnai Osiris introduces for the first time unique ChemiSTEM™ technology which combines technical advances in beam generation with disruptive changes in EDX signal detection. ChemiSTEM comprises the proprietary X-FEG high brightness electron source and Super-X, FEI's new EDX detection system based on Silicon Drift Detector (SDD) technology, and enhances the acquisition speed of EDX chemical mappings by a factor of 50. With ChemiSTEM the collection time for elemental maps in fast mapping mode can be reduced from hours to minutes or from minutes to seconds, compared to standard solutions. This gain in speed can also be used to collect EDX elemental mappings from larger field-of-view in similar times, compared to standard solutions.

The Nova NanoSEM™ scanning electron microscope delivers best-in-class imaging and analytical performance in a single, easy-to-use instrument. With Nova NanoSEM, it is easy to switch instrument conditions based on types of samples being investigated and performing different types of analytical work. The NanoSEM offers two operating modes; a high current beam (essential for rapid EDS/analytical research) and high resolution at high and low voltage resolution at high and low voltage which is essential for image quality across a wide range of sample types. It offers a strong performance in low vacuum mode which gives the researcher more analytical power when there is a need for top quality analytical data on samples like glass, ceramics or other non-conductive materials. The Nova NanoSEM is currently equipped with an Oxford X-MaxN EDS system, and will be equipped with a Bruker X-ray fluorescence (XRF) system in fall 2016.

The JEOL JEM2010 is a 200 kV system including an updated CCD camera, Gatan Erlangshen. The JEOL 2010 enables the study of solid materials with Bright-Field, Dark-Field, SAED and CBED imaging techniques.

Other Equipment:

1) Au sputter coater and Carbon coater
2) Diamond blade slow speed saw and wire saw
3) SBT model 910 lapping and polishing machine
4) Branson 2200 ultrasonic cleaner
5) VCR Group Inc. D500i dimpler and Gatan model 656 dimpler
6) Gatan Inc. model 691 PIPS and PIPS II
7) Leica stereo microscope ZOOM 2000
8) Intek optical microscope
9) Fischione plasma cleaner
10) Fischione disk cutter and SBT model 360 rotation cutter

NCMN Nanomaterials and Thin Films Central Facility

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Function

The Nanomaterials and Thin Films Central Facility (NTFF) provides state-of-the-art instruments for fabricating material samples and devices. A primary focus of the facility is on nanostructuring by using thin-film deposition and multi-layering. The Facility has three thin film deposition systems which can deposit sub nanometer thick films in which two or more materials can be layered together in different order to form a multilayer structure. The properties of such samples or devices will depend on the actual intrinsic property of the nanostructuring such as how the materials interact through the interfaces. The Facility also provides systems to alloy materials together to study the bulk material properties.

Equipment

For thin-film deposition the Facility contains thee systems. The first is a sputtering system ATC-2000F purchased from AJA International. The system contains 4 magnetron sputtering guns (2 DC and 2 RF) which allow in-situ tilting of their heads without breaking vacuum. This permits the user to optimize either uniformity or rate at any working distance in a very short amount of time without venting, resetting the angle, pump down and test. The system can handle substrates up to 4 inches in diameter and the substrate holder will allow simultaneous rotation, heating, RF bias and deposition at up to 850 °C in suitable sputtering environment (600 °C in a pure Oxygen environment). A load-lock chamber and cassette allows the samples to be removed and changed without venting the chamber. The cassette can hold up to 6 substrates holders. The second system is a Pulsed Laser Deposition system PLD-MBE 2500 from PVD Products. The PLD system has a target manipulator that handles six 2-inch diameter targets. Targets are held in pedestals by gravity so target clamping is not required. The system will allow simultaneous rotation of target and substrate. The system allows for in situ heating up to 950 °C and RHEED measurements. The third system is the Hex deposition system from Mantis Deposition Inc. The HEX is a unique compact system which combines a sputtering source and an E-beam source for metals with a thermal evaporator for polymers and an organic evaporator for organic materials. The Hex allows for the use of any of the three deposition techniques to be used simultaneously.

The Facility also maintains several systems to prepare samples in bulk quantities. The Facility has a Materials Research Furnaces Inc. Arc Melting Furnace ABJ-338. The system is a complete, water-cooled, turn-key system for sustained high-temperature use with safety water flow interlock, safety insulated bellows, evacuation/gas system, and a 100% duty cycle power source. The ABJ-338 allows applications such as high-purity melts, creating alloys, powder melting, annealing, and material densification. Next is an Edmund Bühler GmbH Melt Spinner SC which is designed for laboratory applications and can produce up to 10 g of sample per run. The SC has a copper spinning wheel of 200 mm for a maximum surface velocity of 60 m/sec. It processes a small vacuum chamber which is compatible with a high-vacuum pumping system and low power generator. Finally, the Facility also has a Fritsch Pulverisette 7 ball-milling system which is simple and safe to operate. The Pulverisette 7 can handle speeds ranging from 100-1100 rpm and is suitable for materials that are hard, medium-hard or brittle. The Pulverisette 7 ball mill offers an effective method to synthesize novel and nanosized materials.

The Facility also has three tube furnaces. The Lindberg 55322 oven is a Split-Hinge Single Zone Furnace with a Tmax = 1200 °C with a working tube of diameter 2.5 inches. The Lindberg 54233 tube oven has an operating temperature of Tmax = 1500 °C and a working tube of diameter 2 inches. The third furnace is an MTI Compact Vacuum Tube Furnace with Tmax = 1700 °C with a working tube of diameter 2.5 inches The ovens have programmable power supplies/temperature controllers and associated pump stations that can reach a base pressure 5 x 10^{-6} Torr. Applications include ashing, sintering, crystallizing, annealing, etc.

The Facility offers the ASAP 2460 Surface Area and Porosimetry Analyzer for sample characterization. The ASAP determines the surface area and porosity of powders and porous materials using the Brunauer, Emmett and Teller (BET) technique based on nitrogen absorption. Applications include pharmaceuticals, ceramics, nanotubes, adsorbents, fuel cells, paints and coatings, activated carbons and etc.

NCMN Nanofabrication Cleanroom Central Facility

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Function

The Nanofabrication Cleanroom Central Facility (NCF) provides state-of-the-art instruments for designing, fabricating, characterizing and testing of complex nano/micro-scale structures and devices. All of the advanced tool sets are housed within the 4000 sq. ft. clean room in the Voelte-Keegan Nanoscience Research Center. This is a certified class 10,000 (ISO-7) clean room with 2500 sq. ft. work space. There are four functional sectors based on the bay-and-chase configured framework, i.e. Etching, Metrology, Depositing, and Lithography. Real-time monitoring system (hazardous gases, air-born particle concentration, temperature, air pressure, etc.) ensures the clean room running smoothly and safely.

Equipment

The Lithography sector provides four high-resolution patterning systems to meet various requirements of applications in different areas such as MEMS/NEMS, BioMEMS, Micro Optics, Micro Fluidics, Nano-photonics, etc. The electron-beam lithography system provides the highest resolution among all (the reproducible feature sizes are as small as 20nm). The system is composed of a Zeiss Supra 40 field-emission scanning electron microscope and a Raith pattern generator. It is also integrated with a laser interferometer-controlled wafer stage, which makes it possible to accomplish stitching application and multilayer EBL with overlay accuracy better than 50nm on a wide variety of substrates. For photolithography applications, both maskless laser lithography system (Heidelberg DWL 66FS) and traditional mask aligner (SUSS MicroTec MJB4) are available. The Heidelberg DWL 66FS system is a high-resolution pattern generator for low-volume mask making or direct writing on wafers. Using the autofocus function and the interferometer controlled high precision stage, it can write structures down to 0.6 μm with an address grid of 50 nm and multilayer exposure with accuracy up to 200 nm. The MJB4 mask aligner is a high-resolution (down to 0.8 μm) traditional photolithography system for high-volume wafer-level patterning. It also supports fast and accurate alignment both front and back side for multilayer exposures. The last system is the FEI Strata 200xp Focused-Ion Beam (FIB) Workstation. Featuring 30 kV focused Ga^+ ion column, this FIB system is a versatile tool for performing machining work at the micro/nanometer scale, such as creating a cross-section, removing material from selected region or creating any possible shape in various substrates and materials. It is also a superb general purpose tool for high aspect-ratio probe milling, grain-structure analysis, circuit modification and failure analysis, defect characterization, fabrication of nano-patterns, and other related applications.

There are three major systems in the etching sector. The Trion Minilock Phantom III RIE system is a plasma etch system with state-of-art plasma etch capability for single wafers, dies or parts. Accommodating up to six process gases (CF4, SF6, O2, Ar, Cl2, BCl3,), this system can be used for anisotropic dry etching of films such as silicon oxide, silicon nitride, polysilicon, aluminum, GaAs and many others. This reactor can also be used to strip photoresist and other organic materials. The second is the deep RIE system (Oxford Instruments PlasmaPro Estrelas100). Deep reactive-ion etching (DRIE) is a newly developed technique for high aspect-ratio etching applications such as creating deep penetration, steep-sided holes and trenches in wafers/substrates, which requires smooth side wall at high etching rate. The PlasmaPro System can satisfy this requirement because its unique design makes it possible to run both Bosch™ and Cryo etch technologies in the same chamber. Bosch™ process provides high etch rate while Cryo etch technique ensures the smooth side wall. The third system is the Ion Beam Etching/Sputtering System (Intlvac Nanoquest I – UHV). This is a versatile R&D ion beam development platform for both thin film milling and deposition. It works on almost all known solid materials. It also includes eight magnetron sputtering guns for magnetic material disposition and a Secondary Ion Mass Spectrometry (SIMS) probe subsystem for precise etch. The "SIMS" probe allows users to define etch end point and mount of over etch provides the required levels of sensitivity of end point detection.

The Metrology sector provides several instruments for characterization of samples and devices. The Dektak-XT stylus surface profiling system enables the critical nanometer-level film, step and surface measurements with repeatability of under-five angstroms (<5Å). Utilizing a unique direct-drive scan stage, the system can also perform large 3-D surface topology profiling. Featuring Bruker's vision64 operation and analysis software, it provides extensive user-defined capabilities for fast and comprehensive data collection and analysis including thin-film stress analysis. Second, the Filmetrics F40 is a thin-film measurement system which analyzes how the thin film reflects light. It allows non-destructive measurement of film thickness including multilayer film stacks; soft materials that are not suitable for other methods, for instance, Atomic Force Microscopy (AFM). It can also provide other information of the thin film such as color, refractive index and even roughness.

Other Equipment;

1) Optic Microscope with camera (Nikon Eclipse L200N)
2) Four-probe Resistivity Measurement Stand (Lucas 302)
3) E-Beam Evaporator (AJA ACT ORION 8000E)
4) Wire bonder (K&S iBond5000-Dual)

NCMN Surface and Materials Characterization Central Facility

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Function

The Surface and Materials Characterization Central Facility (SMCF) provides state-of-the-art instruments for nanometer-scale characterization of materials surface and physical properties. The SPMC specializes in scanning probe microscopies such as Atomic Force (AFM), Magnetic Force (MFM), Electrostatic Force (EFM), Scanning Tunneling (STM), Piezoresponse (PFM), Surface Potential (PeakForce KPFM), PeakForce Tunneling AFM (PF-TUNA) and Quantitative Nanomechanical Property Mapping (PF-QNM). These SPM instruments have the ability to operate in ambient air, vacuum, and in liquids and can provide three-dimensional high contrast topographic images with sub-nanometer resolution including line width, grain size, roughness measurements, sectioning of surfaces, particle analysis, surface defects, and pattern recognition, etc. In addition to the SPM systems, the facility also offers non-probe based equipment for measuring thermal properties: a Differential Scanning Calorimeter (DSC), a Thermogravimetry Analysis system (TGA), and a polarized microscope equipped with a hot stage with a high temperature capability to 375° C. And also, the SMCF facility includes equipment for measuring mechanical properties of various samples.

Equipment

Bruker Dimension Icon® Atomic Force Microscope is equipped with ScanAsyst® automatic image optimization software, which enables easier, faster, and more consistent results. This system is capable of many SPM applications (contact mode, tapping mode, ScanAsyst peakforce

Mode, AFM in fluid, phase imaging, piezoresponse and many others). The Icon microscope supports PeakForce QNM® Imaging Mode, enabling researchers to map and distinguish quantitatively between nanomechanical properties while simultaneously imaging sample topography at high resolution. This mode operates over an extremely wide range (1MPa to 50GPa) for modulus, and 10pN to 10µN for adhesion to characterize a large variety of sample types. In addition the system allows users to perform nanomanipulation, indentation, and lithography at the nanometer and molecular scales. Users can carry out electrical characterization at the nanoscale with greater sensitivity and dynamic range using exclusive PeakForce TUNA & PeakForce KPFM modules.

The Digital Instruments EnviroScope combines AFM imaging with environmental controls and hermetically sealed sample chamber to perform contact mode and tapping mode atomic force microscopy in air, vacuum, or a purged gas, as well as a heated environment. With advanced environmental capabilities, users can observe sample reactions to a variety of complex environmental conditions while scanning.

The Digital Instruments Nanoscope IIIa Dimension 3100 SPM system provides high resolution, 3D images for a large variety of materials, such as nanoparticles, polymers, DNA, semiconductor thin films, magnetic media, optics and other advanced nanostructures. Magnetic imaging mode can scan samples in external magnetic fields, which is useful for in-situ imaging magnetic domain structures and magnetic switch behavior. Magnetic fields are applied using permanent magnet arrays which can supply magnetic fields perpendicular (± 0.25 T) and/or parallel (± 0.35 T) to the sample surface.

The SMCF also has two systems to measure the thermal properties of materials: a differential scanning calorimeter (DSC 204 F1 Phoenix) and a thermogravimetry analysis system (TGA 209 F1 Libra). Both systems operate through a large temperature range -175°C to 650°C for the DSC and 25°C to 1100°C for the TGA. These systems allow users to study and measure various thermal properties such as glass-transition temperatures, melting temperatures, melting enthalpy, crystallization temperatures, crystallization enthalpy, transition enthalpies, phase transformations, phase diagrams and other thermal properties.

Also, the SMCF houses an Olympus BX51 polarizing microscope which includes differential interference contrast capabilities for sample viewing, and image analysis. In addition the thermal behavior of a sample can be observed under the microscope using a Mettler Toledo FP900 thermal system equipped with a FP 82 microscope hot stage with a temperature range of room temperature to 375° C.

Other equipment;

1) Tukon 2500 Knoop and Vickers tester
2) BUEHLER ISOMet 1000 Precision Saw
3) BUEHLER MiniMet 1000 Grinder-polisher
4) Sartorius Cubis MSU2.7S-000-DM Microbalance

NCMN X-Ray Structural Characterization Central Facility

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Function

The NCMN X-Ray Structural Characterization Facility (XRSCF) is a state-of-the-art X-ray diffraction facility providing users access to modern X-Ray diffractometers. The Facility is dedicated to materials identification and characterization through non-destructive, X-ray Diffraction (XRD) technique. The Facility helps researchers to obtain high quality results by providing hands-on access to the diffractometers and powerful data analysis software. The Facility operates 6 diffractometers: (1) Rigaku Smart-Lab, (2) Rigaku Multiflex, (3) Rigaku D-Max/B, (4) Bruker-AXS D8 Discover High-Resolution Diffractometer, (5) Bruker Photon 100 Single Crystal diffractometer, and (6) PANalytical Empyrean.

Equipment

The Rigaku Smart-Lab is a state of the art high-resolution diffractometer that is suitable for x-ray reflectivity, grazing incidence in-plane x-ray diffraction, high resolution rocking-curve analysis, transmission small-angle x-ray scattering (SAXS), grazing-angle SAXS, pole-figure (PF) analysis and reciprocal-space mapping (RSM) applications. The system offers additional monochromator modules such as Ge (220) x 2 and 4-bounce ones for high resolution diffraction and is equipped with a θ/θ closed loop goniometer drive system, cross beam optics (CBO), and an in-plane detector arm to enable the in-plane diffraction. The 1-D strip detector option in D/teX 250 detector enables fast data collection and the xrf suppression option helps to reduce the influence fluorescence signal when ferrous samples are investigated. . The smart lab has an automated optical alignment system and the guidance software packages that makes it easy to switch between configurations, ensuring that the hardware complexity never holds back the user. The guidance software provides the user with an intelligent interface that guides you through the intricacies of each experiment.

The Rigaku Multiflex consists of 2 kW copper tube and a θ/θ goniometer. The sample holder remains horizontal during the scan and therefore, there is no need to use adhesive substances to mount samples on to a low background sample holder plate. It is also configured in focusing geometry where a secondary monochromator removes the scattered signal except that corresponding to Cu Kalpha wavelength. Pre-aligned sample holder and friendly operating software makes the powder diffraction experiments very easy with this instrument.

In the Rigaku D-Max/, x-rays are produced by a 1.8 kW, sealed tube Cobalt target. The diffracted beam then converges (is "focused") into a scintillation detector passing through a diffracted beam monochromator that removes all radiation except the Co Kalpha wavelength (about 1.7903 Å). The sample and detector are rotated with respect to the incident beam at angles θ and 2θ, respectively. Rigaku D-Max/B diffractometer is ideal for samples that are rich in Co and Fe.

The Bruker-AXS D8 Discover High-Resolution Diffractometer is another state-of-the-art machine equipped with a VANTEC-500 2D detector, centric 1/4-circle Eulerian cradle, domed hot stage, hi-flux in-plane hardware, laser/video sample-alignment system, Göbel mirror, fine tilt stage, and dual-beam path analyzer module. The system can be configured for grazing-incidence in-plane XRD, grazing-incidence XRD, x-ray reflectivity, high-temperature XRD, high-resolution XRD (rocking curves, reciprocal space maps), texture (pole figures), residual stress, and capillary diffraction. Bruker D8 Discover diffarctometer is configured in parallel beam geometry with Cu Kalpha radiation (wavelength of about 1.5418 Å).

The Smart Apex Single Crystal Diffractometer is a dedicated instrument for crystallography studies (absolute structure determination using a single-crystal sample). This instrument delivers intense, monochromatic beam of Mo Kalpha radiation (0.7107 Å) produced using a Graphite monochromator from a sealed Mo X-ray tube and collimated with a pinhole collimator. The sample temperature can be varied from 100 – 500 K using Cryostream controller (Oxford Instruments). The detector (Photon 100 CMOS detector) is placed at about 5 – 6 cm from the sample. The frame buffer computer provided with Apex 3 software suite to help with sample centering, data collection (sample unit cell determination, and detailed structure determination), data integration, absorption correction, and structure determination and refinement.

The PANalytical Empyrean offers high resolution powder diffraction which can be used for; phase identification, phase quantification, crystallinity analysis, and structure refinement. The system uses the PIXcel^{3D} detector which can operate as a point, line and area detector. The maintenance-free PIXel offers superior resolution, fast data collection, extremely high dynamic range, and high count rate linearity. The system uses a PreFIX mounting method of optics and stages which enables the diffractometer to be reconfigured thanks to a reproducible positioning in three dimensions with microns precision. This allows users to switch between different applications in a matter of minutes, making the Empyrean a real multipurpose diffractometer.