SHaRE: A DOE User Facility For Microscopy and Microanalysis

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The Shared Research Equipment (SHaRE) Program at Oak Ridge National Laboratory (ORNL) provides microanalytical facilities to researchers from U.S. universities, industries, and government laboratories for studies within the materials sciences. SHaRE is one of four microscopy and microanalysis research user facilities supported by the U.S. Department of Energy's Office of Basic Energy Sciences (BES). All BES user facilities, including SHaRE, are available to in order to foster collaborative research, scientific leadership, international competitiveness, and the education of graduate students being prepared for careers in materials science. Based on the scientific excellence and relevance of the proposed experiments, free operating time is available to researchers who then publish their results in open literature. Proprietary research can be accomplished on a full cost-recovery basis or by Cooperative Research and Development Agreements (CRADAs). However, services that can be purchased from commercial laboratories are not appropriate for the SHaRE Program.

Within the Metals and Ceramics Division at ORNL, the Microscopy and Microanalytical Sciences Group is responsible for maintaining and developing the analytical electron microscopy (AEM), atom probe field ion microscopy (APFIM), and mechanical properties microprobe (MPM) facilities available under the SHaRE Program. Staff from the group collaborate with external users and provide a core of expertise and talents upon which the SHaRE projects draw. Additionally, there are other M&C Division staff who also act as collaborators for various projects. A primary thrust area for the M&C Division (and therefore most SHaRE projects) is structural materials and the correlation of structure with properties for a wide range of metallic, ceramic, and composite materials. Additional SHaRE projects have dealt with the characterization of magnetic materials, catalysts, semiconducting device materials, high T_c superconductors, and surface-modified polymers.

The SHaRE facilities are being enhanced by the installation of three new instruments late in the summer of 1994. A Philips CM200 (200 keV) Schottky-FEG TEM-STEM electron microscope will provide state-of-the-art AEM with both light element energy-dispersive spectrometry (EDS) and electron energy-loss spectrometry (EELS) capabilities. A Philips XL30 Schottky-FEG scanning electron microscope (SEM) will be equipped for bulk elemental analysis, microstructural analysis, and screening of many materials prior to the application of higher spatial resolution techniques (AEM and APFIM). Also, a Gatan Imaging Filter will permit 300 keV post-column energy filtering for energy-loss mapping (elemental or compositional "images" approaching 1 nm resolution) and improved TEM penetration (images and diffraction patterns) by reduction of chromatic aberration effects. A 3-dimensional mapping atom probe (MAP) is under development and will be included when fully functional and user ready.

The current characterization facilities covered under SHaRE include three AEMs, two APFIMs, three MPMs, and an atomic force microscope (AFM). A Philips EM400T-FEG AEM is equipped with a high brightness field emission gun (FEG) for experiments requiring high beam current in a small probe (-1 nA in -2 nm diameter FWTM probe). A Philips CM12 120 kV AEM is microprocessor-controlled and equipped with both wide-angle and high resolution video cameras for dynamic studies. For high resolution electron microscopy with lattice and structural imaging to -0.23 nm, a Philips CM 30 300 kV microscope is available. This instrument is particularly useful when greater penetration is required, or for investigations involving ferromagnetic materials. These analytical electron microscopes are configured to provide capabilities including EDS, EELS, convergent beam electron diffraction (CBED), and scanning transmission electron microscopy (STEM). Video imaging and recording allows high resolution imaging and dynamic investigations. A variety of specimen holders enable experiments to be conducted over a side range of temperature, orientation, or stress-state.

Share has unique atom probe field ion microscopy facilities. Combined APFIM and AEM studies can provide detailed microstructural and elemental analysis and the highest spatial resolution possible. One available atom probe includes a field ion microscope, a field emission microscope, a reflection type energy-compensated atom probe, and an imaging atom probe. A second APFIM provides the capabilities of a field ion microscope, a field emission microscope, an energy-compensated atom probe, an imaging atom probe, and an optical atom probe. Radioactive specimens may be examined in this instrument.

Mechanical properties of materials at the nanometer scale can be investigated by three mechanical properties microprobes (MPM). The MPM can precisely measure the mechanical properties of small volumes of material. Both elastic and plastic mechanical properties can be determined at high spatial resolution from the load-displacement data. Using programmed loading sequences from 0.05 to 300 mN, indentations as shallow as a few nanometers can be routinely made. Temperature is an important variable affecting the mechanical properties of materials. A high temperature mechanical properties microprobe (HTMPM) has recently been developed at ORNL. This instrument uses phase sensitive laser interferometry to accomplish displacement measurements and can currently conduct nanoindentations at temperatures up to 300° C. The capability to make nanoindentations at higher temperatures is under development.

Available under SHaRE is a Park Autoprobe-XL AFM which is equipped with an optical-based position-sensing system to obtain accurate quantitative measurements. This AFM can operate in either the repulsive mode for examining hard materials or in the attractive mode for examining soft materials.

Participation in the SHaRE Program is accomplished by letter proposals from principal investigators. These briefly describe the proposed collaborative research and are submitted to the SHaRE Executive Committee. This committee must approve proposed research before participation is possible. Approval is based upon scientific excellence of the proposal, relevance to DOE goals, and when applicable, the previous SHaRE-sponsored research record of the proposers. The Executive Committee is composed of representatives from ORNL research staff, Oak Ridge Institute for Science and Education, and external users currently participating in the program.

All SHaRE projects are reviewed annually. Two types of research projects

are supported under SHaRE. Exploratory research projects are permitted to test the feasibility of a research idea. Such research is short term and can require the direct assistance (equipment operation) of an internal ORNL staff member. Often, successful completion of exploratory research projects lead to extended collaborative research. These require the continued participation of the internal staff members. Here, after appropriate training, the external participants become more active in the experiments and long-term research goals are set.

In summary, SHaRE is an established and active program with expectations for continued growth. In the program's 15 year history, over 300 external users have conducted collaborative research at ORNL. At any given time, approximately 25 collaborative research projects involving about 40 external users are in place. In a typical year, the program is acknowledged in some 25 publications and 25 conference presentations, and, of the 15 to 20 graduate students working in the program, 5 will successfully complete their graduate studies.

Proposals for program participation are accepted at any time. However, most projects are approved in October for participation in a fiscal year beginning October 1 and ending September 320. For additional information regarding participation in SHaRE please contact:

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Electron Optics Facility Engineer

The Department of Metallurgical and Materials Engineering at Michigan Technological University has an opening for an engineer who will be responsible for operation, maintenance, repair, and supervision of microanalytical instruments in its Electron Optics Facility. This facility includes several scanning electron microscopes, transmission electron microscopes, and an electron microprobe. Successful candidates will have training and experience in operation, maintenance and repair of similar instruments in a research setting. Duties may include collaboration with faculty and graduate students in preparation of research proposals, development of new microanalytical methods and publication of research. Interested applicants should send a resume´, including names and addresses of three professional references, to the following address:

Chair, Electron Optics Facility Engineer Search Committee
Department of Metallurgical and Materials Engineering
Michigan Technological University
1400 Townsend Drive
Houghton, MI 49931-1295

Salary range for this position is $34,261-$54,818/yr, starting salary will depend on experience and qualifications. The search committee will begin reviewing applications on August 1, 1994. Applications will be accepted until the position is filled.

Michigan Technological University is an equal opportunity employer/ educational institution and welcomes applications from all qualified applicants.