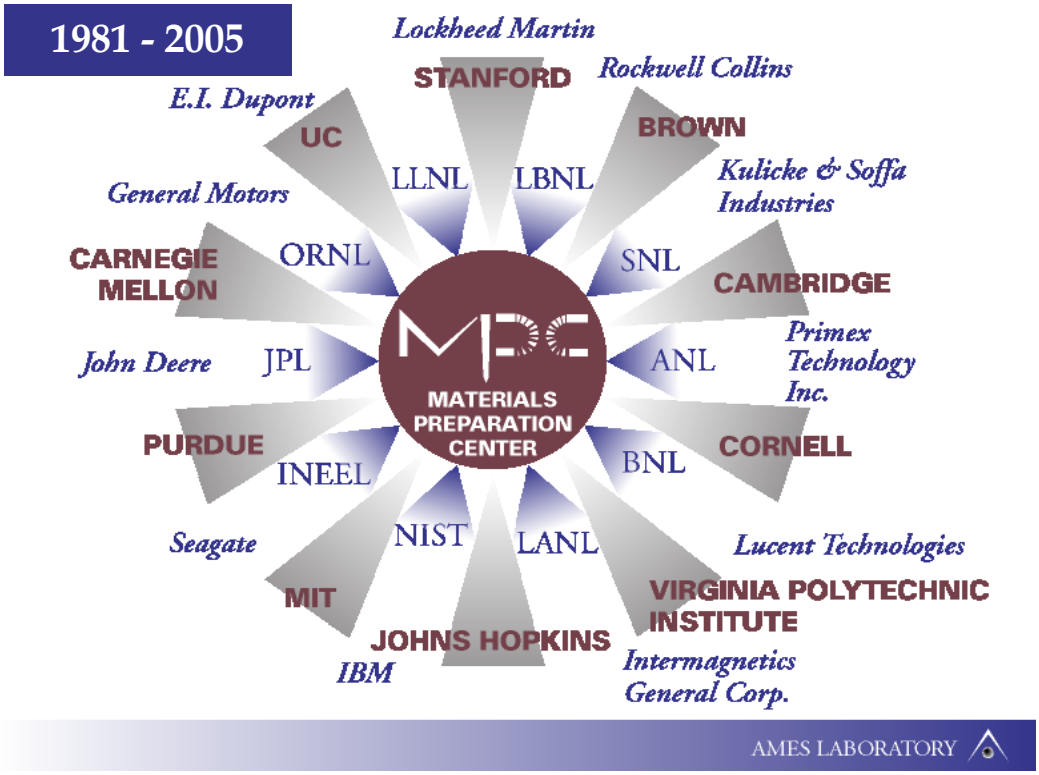
MATERIALS PREPARATION CENTER



MPC CIRCLE OF SELECTED USERS

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INTRODUCTION AND HISTORICAL PERSPECTIVE

The Materials Preparation Center (MPC), established within the Ames Laboratory in October 1981, is one of DOE's twenty-two designated "BES Scientific User Facilities," specifically the MPC is a *Specialized Single-Purpose Scientific User Facility*. Since its inception the MPC has operated under the auspices of the Materials & Engineering Physics Program (formerly called the Metallurgy and Ceramics Program).

One of the primary motivations for the formation of the MPC at Ames Laboratory was to provide the materials science community, particularly associated DOE Laboratories, effective access to the unique materials processing expertise of the Ames Laboratory. A simple access mechanism was established for the MPC to provide researchers with extremely high-quality (chemical purity, crystalline perfection, compositional uniformity, controlled particle size, etc.) materials in forms that enable the efficient conduct of crucial fundamental experiments without materials limitations. These capabilities were developed at the Ames Laboratory during the course of 50+ years of DOE sponsored basic energy research in the development of materials, processes, and chemical characterization techniques for energy research. Since the MPC charter is to supply only materials which are not available from any commercial source, it can be stated firmly that many of the crucial fundamental experiments conducted by DOE scientists and others would not have been possible without the materials provided by the MPC. Indeed, MPC expertise and facilities for the processing of laboratory-scale samples are unique not only to the DOE, but also to the world.

During its ~24 years of operation, the MPC has satisfied over 4,000 requests for the preparation, purification, fabrication, and characterization of materials placed by DOE and other government laboratories, industrial laboratories, universities and foreign institutes.

The MPC has established a considerable suite of materials processing equipment and has developed a deep knowledge base in the operation of this equipment. The processing equipment utilized by the MPC includes both general-use commercial equipment and unique research equipment that was designed and fabricated by the research staff of the Ames Laboratory. Processing techniques that have been recently added to the MPC ensemble include: a state-of-the-art melt spinner with extensive diagnostic capabilities, a plasma-arc melter for the preparation of highly reactive alloys, high pressure gas atomization, and a complete laboratory for single-crystal preparation. The processing science expertise utilized by the MPC includes both permanent MPC technical staff members and many of the scientific and technical staff members of the Ames Laboratory. These capabilities have been applied to the preparation of many new and unique materials to meet the needs of researchers in fields including materials chemistry, magnetism,

superconductivity, electronic materials, energy storage, and power generation, among others. A key strategy maintained by MPC has been to ***enable fundamental research in a vast array of scientific disciplines by providing the novel crucial materials that are required in well-controlled purity, specified physical form, and desired microstructure.*** Because assistance in these materials preparation tasks is often provided to MPC by undergraduate and graduate students enrolled at Iowa State University, the Ames Lab contractor, many special skills are imparted to successive generations of engineers and scientists.

Mission of the MPC

The MPC mission is to provide high-purity, high-quality, and well-characterized materials in support of research and development programs at the Ames Laboratory and other government, academic, and private industry laboratories throughout the world.

MPC will be a source and developer of unique capabilities in the preparation, purification, processing and fabrication of metallic elements and alloys for advanced energy and technology research and is to transfer these developments to U.S. industries where possible.

MPC staff will contribute to the scientific training of undergraduate and graduate students in the disciplines of materials preparation and characterization.

All MPC work is performed on a cost recovery basis and is non-competitive to commercial entities.

PROCESSING SCIENCE WITHIN THE MPC

The MPC regularly conducts innovative process developments in response to requestors seeking certain materials. This role of enabling fundamental research by the preparation of unique, high-quality materials is essential to the realization of the ideas generated by scientists in many fields. Moreover, this extremely important, yet understated role, serves as one of the scientific drivers of the MPC. Further, while serendipity often plays a role in the discovery of new materials, gaining a fundamental understanding of the physical, chemical and mechanical properties of new compounds can only come about by reproducibly synthesizing high purity and microstructurally homogeneous materials. Excellent examples of the MPC expanding the scientific frontiers of materials synthesis and processing to play critical role in enabling fundamentals research can be found in the preparation of quasicrystals and novel compounds containing rare-earth metals, such as the magnetic refrigeration materials ($Gd_5Ge_2Si_2$). In both cases, the MPC has established itself as a world leader.

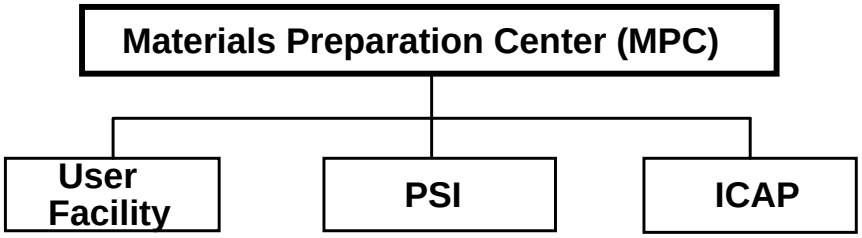
The MPC also performs processing-related research via the “Process Science Initiative” (PSI), which was established in FY2000 at a funding level of $300K per year. From its inception, the PSI program was quite successful; however, the level of effort required to review, initiate, and then monitor multiple projects was significant. In addition, the requirement of an Intellectual Property/Nondisclosure Agreement sometimes resulted in project initiation delays. The encumbrances associated with administering the PSI program, coupled with programmatic needs for processing science within nascent research efforts, led to a reformatting of the PSI. In the new format, the PSI provided for an expansion of synthesis and processing science efforts specific to the Program’s research portfolio so as to enable greater progress in the experimental, materials-dependent research being conducted. This revised approach maintains processing science as an identifiable effort within the Program and also maintains an important original intent of the PSI program, which is to improve the MPC’s specific knowledge base in synthesis and processing science. Two-page write-ups of current PSI efforts are presented in the following section.

Thus, on one level, the MPC enables scientific excellence by preparing research samples of significant quality and size. There is a great deal of science associated with this, to the extent that the continual need for unique material samples is, itself, one of the science drivers for the MPC. On yet another level, the

MPC is involved via the PSI in basic science efforts directed toward the preparation of materials that are specifically germane to BES-supported projects.

ORGANIZATION

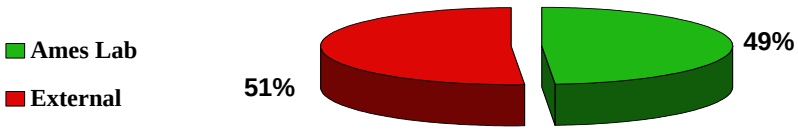
The MPC is organized into three functional areas: the "User Facility" which provides materials and services in support of research; PSI which provides funding for processing science projects; and the Institute for Physical Research and Technology (IPRT) Company Assistance Program (ICAP), which is a technical outreach program.



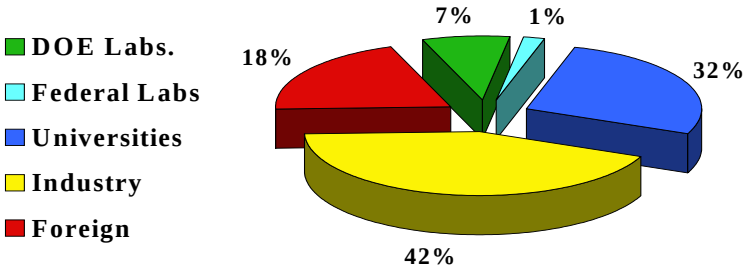
Within the "User Facility" there are four functional Materials Preparation sections: synthesis of high purity rare earth metals and alloys; alloy preparation; single crystal processing; and metallic powders processing. In addition to these four materials preparation sections, the MPC also supports electron-beam characterization and microscopy services, including capabilities in metallography and analysis of interstitial gases.

RESOURCES

MPC receives operations and equipment funding from the DOE-BES for support of the User Facility and PSI. Further MPC support is derived from the materials and services work it performs on a cost-recovery basis for both internal and external users. During FY2005 MPC provided materials and services to internal and external users in the proportions shown below.



During FY2005 the MPC completed 205 external orders for the following entities:



MPC SPACE AND FACILITIES

The MPC has laboratory space in two Ames Laboratory buildings. Within the Metals Development building the MPC houses most of its materials preparation and fabrication equipment. In many of these areas the MPC shares space with the research staff of the Materials & Engineering Physics Program providing an integrated environment where natural collaborative efforts with the research programs thrive. MPC's metallography lab is also found in the Metals Development building. In total, the MPC has responsibility for over 16,000 square feet of laboratory area in the Metals Development building.

The electron-beam characterization instruments (*i.e.*, SEM, EPMA, STEM, and AES) are located in Wilhelm Hall. Also within Wilhelm Hall are the powder consolidation facilities for hot and cold isostatic pressing equipment.

The range of the equipment operated and maintained by the MPC is extensive. Facilities include melting and casting systems utilizing arc, electron beam, and induction heating, a variety of vacuum and inert gas atmosphere heat treating furnaces, and fabrication equipment including rolling mills, extrusion presses, swaging machines, and wire drawing benches. Special facilities exist for production of metal powders, single crystal synthesis and deposition of coatings by thermal spray. A complete listing of the MPC equipment and instrumentation can be found at the MPC website www.mpc.ameslab.gov.

SELECTED ACCOMPLISHMENTS 2000 -2005

Preparation of La-Ni-Sn cryocooler bed material for the ESA/NASA Plank. The hydrogen storage bed materials will be used for the space-based observation vehicle, scheduled for launch in 2007.

Set the benchmark for Al-Y-Ni-X powder materials performance and purity for DARPA's Structural Amorphous Materials (SAM) Program, Pratt & Whitney/Boeing led team.

Prepared high-grade aluminide powders for ORNL Fossil Energy Program candle filter research effort.

Prepared powders for DARPA Program for non-DU Kinetic Energy Penetraters.

MPC prepared high purity calcium and cerium metal for Kulicke & Soffa South East Asia Pte. Ltd., which is used in manufacturing of ultra-fine gold wire for ball-bonding computer chip, interconnects.

Development of alloying procedures and processes for preparation of magnetostrictive alloys.

Development of alloying procedures and fabrication processes for preparation of high strength, high conductivity ultrafine microcomposites of copper-refractory metal alloys for aerospace applications.

Preparation of $PrNi_5$ for use in Adiabatic Nuclear Demagnetization Refrigeration (National High Field Magnetic Laboratory, Tallahassee, Florida).