Center for Materials Science and Engineering

The National Science Foundation (NSF)–funded Materials Research Science and Engineering Center (MRSEC) at MIT was established in 1994 as the core program of the Center for Materials Science and Engineering (CMSE). CMSE promotes and facilitates interdisciplinary research and education in the science and engineering of materials. MIT has an exceptionally strong and broad effort in materials science and engineering involving more than 110 faculty members in 12 different departments in the schools of Engineering and Science. CMSE plays the critical role of bringing this diverse materials community together by encouraging and supporting collaborative research and innovative educational outreach programs and by providing state-of-the-art shared experimental facilities. The clear and important mission of CMSE is to encourage fundamental research and education in the science and engineering of materials for long-range applications that will address the future needs of society. The complexities of such research clearly require input from industry and the expertise of many faculty working collaboratively in a team-based approach. To accomplish this important mission, CMSE enables collaborative, interdisciplinary research among MIT faculty and among MIT faculty and the researchers of other universities, industry, and government laboratories.

CMSE promotes collaborative research through several mechanisms: interdisciplinary research groups (IRGs), seed and initiative projects, shared experimental facilities (SEFs), and outreach programs. While seed funding preference is given to young faculty, CMSE uses seed and initiative funds to support research that has the potential of redefining the direction of an existing IRG or leading to the creation of a completely new IRG. Seed funding provides CMSE with the flexibility necessary to initiate high-risk research. Our research programs typically support a total of 35 to 40 faculty members from six departments.

Our SEFs are used by numerous research groups from MIT, as well as outside academic and industrial communities. Last year, approximately 700 people used our SEFs, including students and postdocs of 110 MIT faculty in 20 academic departments, labs, and centers; students and staff of 35 faculty from 14 outside academic/research institutions; and the staff of 16 senior-level industrial managers.

Our educational outreach programs encompass a broad range of activities and age levels, with participation from K-12 students and teachers and undergraduates from other institutions. Last year, approximately 220 people participated in our various programs with support from CMSE-funded faculty, graduate students, and postdocs.

Our industrial interactions/knowledge transfer activities have resulted in the establishment of new products, applied funding, a new MIT center (Microphotonics Center) and numerous start-up companies. For example, several small companies have emerged from, or are based in part on, CMSE research, including Clarendon Photonics, Little Optics, Cumulus Photonics (now defunct), OmniGuide Communications, American Superconductor, Quantum Dot Corporation, LumArray, and Luminus

Devices, Inc. All of our activities are highly integrated and often combine elements of research with educational and industrial outreach.

Administration, Management, and Research

Our MRSEC program is administered by a proactive and effective management team capable of responding quickly to the emerging needs of the program. Currently, six administrative and eight SEF staff support the program. The administrative staff includes an education officer, facilities and safety coordinator, financial administrator, financial and operations assistant, assistant to the director, assistant director, and director. The SEF staff includes two technical associates, three research specialists, a half-time specialist, a principle research scientist, and a facilities manager/principle research scientist. The CMSE director reports directly to the vice president for research and associate provost; the assistant director reports to the director, and all other staff, including the facilities manager, report to the assistant director. Our current director also serves as CMSE's chemical hygiene officer. CMSE currently has a faculty education program leader who marshals our educational outreach plans with our education officer.

The activities of CMSE are guided and supported by four internal and two external committees. The Education Committee, Safety Committee, Space Committee, and Internal Advisory Committee are internal MIT committees that offer guidance to CMSE on educational matters, space, safety, and research. The External Science and Engineering Advisory Board and the Committee on CMSE offer guidance on ways to enhance collaborations and support major efforts in long-range materials research and engineering.

In July 2002, CMSE was awarded a $22.2 million grant from NSF through the MRSEC program. This grant covers the funding period from September 1, 2002 through August 31, 2008. In September 2005, we will host a site visit from NSF. This past winter we submitted a non-competing continuation proposal that described our activities during the third period of funding of our MRSEC grant.

Interdisciplinary Research Programs

CMSE currently supports four IRGs, two initiatives, and five seed projects involving 38 principal investigators. These are summarized below. This past year, a decision was made to phase out Initiative I.

Seed and initiative funding plays a critical role in the vitality of MRSEC. The primary goals are to support research that has the potential to: (a) redefine the direction of an existing IRG, (b) create a new IRG, or (c) provide an opportunity to move quickly into new research areas.

IRG-I: Microphotonic Materials and Structures

Microphotonic materials are rapidly emerging as one of the most promising new platforms for future optical devices and device components. Such materials allow an unprecedented level of control over the confinement and propagation of light, at dimensions that enable the design and eventual integration of a large number and

variety of optical micro devices on a single chip. The objective of this IRG is to explore materials issues and fundamental properties of photonic crystals, to discover physical phenomena associated with photon states that have never been possible before, and to exploit this knowledge with the ultimate aim of the design, fabrication, and characterization of novel microphotonic devices and components.

Participating faculty and departmental affiliations: J.D. Joannopoulos, IRG leader (Physics); E.P. Ippen, L.A. Kolodziejski, and H.I. Smith (Electrical Engineering and Computer Science); L.C. Kimerling and Y. Fink (Materials Science and Engineering); and K.A. Nelson (Chemistry).

IRG-II: Nanostructured Polymer Assemblies

Polymers and polymer nanocomposites with functional electronic, optical, and biointerface properties are becoming increasingly important in many new technologies that exploit nanoscale-related properties and effects. This IRG seeks to gain a fundamental understanding of the factors that control the way multicomponent, functionally active polymer systems organize at the molecular and nanoscale levels and to use this knowledge to control and significantly enhance the performance of electronic, magnetic, biosensor, and optical devices based on these materials.

Participating faculty and departmental affiliations: A.M. Mayes, IRG leader (Materials Science and Engineering); R.E. Cohen (Chemical Engineering); and P.T. Hammond, C.A. Ross, M.F. Rubner, and E.L. Thomas (Materials Science and Engineering).

IRG-III: Electronic Transport in Mesoscopic Magnetic and Semiconductor Structures

Modern electronics have provided the foundation for the scientific and technological advances of the last few decades, but will soon face serious obstacles that may further limit miniaturization and development. Nanoscale elements, with properties dominated by quantum mechanics, are expected to play an important role in overcoming many of these barriers. The focus of this IRG is to explore charge and spin transport in solid-state electronic structures whose building blocks are in the nanometer size regime in order to understand the fundamental physical principles governing transport through and between these potentially important building blocks of future electronic devices.

Participating faculty and departmental affiliations: M.G. Bawendi, IRG leader (Chemistry); R.C. Ashoori, M.A. Kastner, L.S. Levitov, and X.G. Wen (Physics); and V. Bulovic and R.J. Ram (Electrical Engineering and Computer Science).

IRG-IV: Science and Engineering of Solid-state Portable Power Structures

The need for efficient portable power is extremely important in today's society and is becoming critically important to many new technologies that will impact consumer electronics and communication, health monitoring, entertainment, environmental oversight, and national security. This IRG seeks to develop the basic science and engineering of materials for solid-state electrochemical power sources, and to use this fundamental knowledge to design devices with energy and power delivery capabilities

far superior to those of anything available today. The knowledge gained from fundamental materials studies is expected to have a real impact on practical advances in the battery field.

Participating faculty and departmental affiliations: G. Ceder, IRG leader (Materials Science and Engineering); E.A. Fitzgerald, A.M. Mayes, D.S. Sadoway, and R.L. Smith (Materials Science and Engineering); Y. Shao-Horn (Mechanical Engineering); and M.Z. Bazant (Mathematics).

Initiative Project I: Chemically Responsive Organic Optoelectronics

The objective of this initiative is to design reproducible, high-performance organic-based transistors and sensors capable of amplified responses to chemical targets. To accomplish this, the group is developing new methods for the deposition of novel active and passive (protective coatings) molecules and polymers. Chemical specificity in the sensory responses is accomplished by designing materials with specific electronic structures, nanoscopic superstructures, and integration receptors. Particular emphasis is placed on receptors of biological origin, as a result of their exquisite selectivity.

Participating faculty and departmental affiliations: T.M. Swager, initiative leader, (Chemistry); V. Bulovic (Electrical Engineering and Computer Science); K.F. Jensen (Chemical Engineering); and R.J. Silbey (Chemistry).

Initiative Project II: Exotic States of Correlated Electrons in Single Crystals

The overall objective of this initiative is to discover and understand the exotic phases that arise in materials with strongly interacting electron systems. Materials of this type can exhibit unusual properties such as superconductivity, anomalously high thermopower, or infinite ground-state degeneracy. Single crystals of the newly discovered super conductive cobaltates will be synthesized and studied with the specialized techniques of neutron and synchrotron X-ray scattering and scanning tunneling microscopy (with atomic resolution).

Participating faculty and departmental affiliations: Y. Lee (Physics) and D. Nocera (Chemistry), initiative coleaders; E. Hudson (Physics); and F.C. Chou (CMSE)

Seed Projects

- Regular Nanofluidic-PEM Membrane as a Model System for Studying Ion Transport in Charged Membrane, J. Han (Electrical Engineering and Computer Science)
- Modeling and Design of Three-dimensional Nano-Acoustic Devices and Phononic Crystals, S.G. Johnson (Mathematics)
- Electron Transport Studies in Single-walled Carbon Nanotubules, Jing Kong (Electrical Engineering and Computer Science)

- Realistic, Quantitative Descriptions of Electron-transfer Reactions: From Electrochemistry to Molecular Electronics to Biochemistry, N. Marzari (Materials Science and Engineering)
- Engineering Nanoscale Polymer Films as Tunable Mechanical Substrata, Krystyn Van Vliet (Materials Science and Engineering)

Scientific Accomplishments During the Past Year

IRG-I has succeeded in the first fabrication of a micron length scale 3-D photonic crystal with an intentionally designed point defect that acts as a microcavity. This important development moves the emerging area of microphotonics closer to the realization of large-scale integrated devices. Members of this IRG have also designed and fabricated the first optoelectronic photonic band-gap fibers and demonstrated their use as large-area, tunable photodetecting fabrics. The potential application of these fabrics as chemical/biochemical sensors for homeland security looks very promising.

IRG-II research has led to the development of ultra–water-repellant coatings that can be readily applied to most surfaces. These superhydrophobic coatings show promise in self-cleaning surface applications as low flow resistance coatings for pipes and microfluidic devices and as bacteria adhesion–resistant coatings. This group has also demonstrated the fabrication of highly ordered arrays of nanomagnets by using grooved surfaces to control the ordering of spherical block copolymer domains. Creation of magnetic storage media with significantly increased densities may be possible through this approach.

In IRG-III, photoconductive nanocrystal arrays with the ability to convert 100% of incident light into electrons have been demonstrated, thereby suggesting the development of high-efficiency, nanoparticle-based wavelength tunable photodetectors. Red, green, and blue hybrid nanocrystal/organic semiconductor light-emitting devices have also been fabricated, the function of which is based on a single monolayer of nanoparticles sandwiched between layers of an organic semiconductor.

IRG-IV members have discovered that an unusual flower-like arrangement of atoms in a new lithium battery cathode material limits its full theoretical capacity. Overcoming this structural limitation is expected to result in batteries with significantly longer lifetimes. In addition, this group has created the thinnest solid-state electrolyte layer ever utilized in an ultra-thin integrated battery, moving them closer to fully integrated battery-on-a-chip designs.

Research in Initiative-I has resulted in a semiconducting polymer thin film device with a 30-fold higher sensitivity to explosive vapors from molecules like TNT, promising explosive sensors with unparalleled sensitivity.

Using high-quality single crystals grown within our SEFs, Initiative-II research has revealed new fundamental insights into the behavior of both geometrically frustrated magnets based on the Kagomé lattice and a hydrated cobalt oxide compound with an anomalously large thermopower.

In a very exciting development, photonic fiber technology developed by a company founded by MRSEC-supported faculty (OmniGuide) has been used to operate on a patient with recurrent severe obstruction of the larynx and trachea. In contrast to the numerous times that this operation was carried out on this patient in the past, she was awake during the procedure, required no anesthesia, and was able to go home immediately following the procedure. This new technology is a direct outcome of fundamental research carried out within MRSEC.

Shared Experimental Facilities

Our SEFs are a critically important resource to our MRSEC program and to the MIT community, as well as a number of outside academic and industrial organizations. Currently we run four major facilities: Materials Analysis, Crystal Growth and Preparation, Electron Microscopy, and X-ray Diffraction. A team of highly motivated professionals staff these facilities. During this past year, about 700 different individuals utilized our facilities.

Beyond the special role our SEFs play in the training and education of MIT students, they are also an important part of CMSE's education programs. Undergraduates participating in the summer internship programs (Research Experiences for Undergraduates and Roxbury Community College) are trained to use equipment in the SEFs to conduct their research. Teachers in the Materials Research Experience for Teachers program spend one morning each week learning about the capabilities and research applications of the equipment in the SEFs. Some of them are also trained to use the instruments for their research projects. Finally, the SEFs are included in visits to CMSE by various groups of middle and high school students.

Key activities during this past year include the following:

- The establishment of an MIT-wide working group put together by vice president for research and associate provost Alice Gast to coordinate the needs assessment and purchase of major equipment and to establish best practices for operating user facilities at MIT. This new working group is chaired and cochaired by the CMSE director and facilities manager, respectively.
- A review by CMSE of a new facilities software package, CORAL, that promises to significantly improve the operational aspect of our facilities. Several members of the Facilities Managers Working Group are reviewing this software for proposed implementation at MIT.
- An increase to CMSE SEF rates was implemented in March 2005, with the intention of hiring a new, much needed, SEF staff member.

Collaboration, Outreach, and Knowledge Transfer

Our MRSEC-supported faculty has ongoing collaborations with numerous industrial partners that range from the funding of applied projects (often based on fundamental work carried out within the center) to the development of new technologies and products. We work closely and effectively with MIT programs and centers, such as the Materials Processing Center (MPC) and the Industrial Liaison Program (ILP), which connects MIT research to industry. These organizations combined have more than

200 member companies. This past year for example, ILP arranged some 170 meetings between our MRSEC-supported faculty and representatives from a broad range of different domestic and foreign companies. Presentations made by CMSE faculty at MPC and ILP–sponsored conferences reached representatives from about 90 different US companies, 40 foreign companies, and nine US and foreign government agencies.

Technologies developed based on fundamental discoveries made within our MRSEC program have helped to launch a number of new start-up companies, including the most recent, QD Vision, which was established in 2004 using technology licensed from MIT (based on IRG-III research). These companies were founded to develop novel devices and components based on discoveries made within our MRSEC program and funded in many cases exclusively through NSF. In 2004, 14 new patents were issued, 12 new patent applications/provisional patents were submitted, and five licenses were granted that are related to MRSEC.

During this past year, our faculty reported collaborations with 15 different industrial organizations, 32 outside academic institutions, and 13 government laboratories and agencies that were MRSEC-related, representing a total of 81 different individuals. International collaborations include the University of Twente (Netherlands), Istanbul Technical University (Turkey), University of Ioannina (Greece), Tokyo Institute of Technology (Japan), CNRS Bordeaux (France), National University of Singapore, Laboratorio TASC-INFM (Italy), University of Taiwan, Research Council of Canada, Toth Information Systems, Inc. (Canada), McMaster University (Canada), ETH Zurich (Switzerland), Max Planck Institute (Germany), and the École Superièure de Physique et de Chimie (France).

Education and Human Resources

Over the past five years, we have worked hard to establish a wide-reaching and diverse portfolio of educational outreach programs that are both innovative in nature and responsive to the needs of educators and students. We have now put in place a broad range of well-received programs that impact high school students and teachers, as well as undergraduate and graduate students. Our programs are managed by a full-time education officer who works closely with a faculty education program leader, the center director, and the assistant director. In addition, the center's educational outreach committee consults on the direction of the education programs and the coordination of those programs with other outreach programs on campus. The committee's membership is comprised of personnel from MIT who are actively involved in educational outreach efforts. Besides involvement in CMSE's formal education activities (outlined below), MRSEC-supported faculty, research scientists, and graduate students participate in outreach activities with local schools and with religious communities and professional organizations. Our faculty reported that over the past year they devoted about 263 hours to tutoring students; making presentations at schools, youth groups, and teacher meetings; or hosting groups of students visiting MIT laboratories. The 385 students and 207 teachers who participated in these efforts are affiliated with 12 different organizations external to MIT.

Pre-college Education

Materials Research Experience for Teachers

For the past six years, CMSE has operated a successful Materials Research Experience for Teachers (MRET) program. This program brings high school and middle school teachers to MIT to participate in CMSE research. The teachers spend seven weeks immersed in research during the first year of the program, then are invited to return the following summer for a flexible period of time devoted to the development of material that will transfer their research experience to their classroom teaching. The major components of the program are research, weekly discussion meetings, SEF tours, and the development of classroom materials. An important goal of the program is to document the materials developed by the teachers so that they can be shared with other educators. Lesson plans written by the teachers are distributed to other science teachers and used in teacher workshops. One lab unit has been published in the *Journal of Chemical Education* (Vol. 81, No. 11, Nov. 2004, p. 1620). Thirteen teachers are participating in this program during the summer of 2005, six working on research and seven creating classroom materials.

Science Teacher Enrichment Program and Women's Technology Program

CMSE offered its Science Teacher Enrichment Program (STEP) for the fourth time in the summer of 2005. The goal of the program is to deepen the teachers' content knowledge in areas related to the state learning standards. It consists of a one-week, hands-on workshop entitled "Dustbusting by Design," in which the participants enhance their knowledge of the engineering design process by immersing themselves in it. After considering the special features of a hand-held vacuum, the physics of its operation, and the properties of the materials involved, the participants design and construct motors that meet the machine's performance specifications. The final day of the program is devoted to a brainstorming session among the teachers and Professor Steven Leeb, CMSE's faculty education leader, about classroom projects to transfer the teachers' experience to their students.

A companion effort to STEP is CMSE's collaboration in the Women's Technology Program (WTP). The Department of Electrical Engineering and Computer Science administers this four-week summer residential program for 40 high school girls from across the country, during which the participants take classes in math, computer science, and engineering. The program is designed to address a gender imbalance in the field of engineering by increasing the girls' interest and confidence in pursuing engineering careers. CMSE invites the WTP participants to join the lab portion of STEP to gain hands-on engineering experience. For the past three years, this has turned out to be an extremely successful collaboration. WTP alumni report that this motor-building lab was the most exciting part of the program. CMSE continues to support WTP by providing the curriculum and supplies for this part of their program in 2005.

Science Teacher Workshops

CMSE offers workshops that address specific content enrichment needs to groups of science teachers. These are developed in consultation with the teachers, particularly with former participants in MRET and STEP. In fall 2004, Professor Leeb led a workshop for

22 junior and high school teachers at a special program preceding the Materials Research Society (MRS) Fall Meeting in Boston. At Boston's Museum of Science, he conducted a hands-on class for the teachers in which he explained the operation of the direct current motor and the design considerations in building motors for a variety of applications. After his talk, he led the teachers in building simple motors. They left the workshop with their motors, as well as detailed instructions and a lesson plan written by Kristy Beauvais, a former MRET participant.

At the same event, Felice Frankel, a research scientist at MIT who collaborates with CMSE researchers, and two MRET participants, Sean Müller and Michael Cirelli, presented a workshop on using the photography and imaging of science to help students learn about science. Approximately 20 participants had opportunities to use the strobe and light meter built by the MRET teachers at CMSE to capture photographically phenomena that occur too rapidly for the human eye to see. The attendees were given suggestions for using inexpensive materials to build some of the equipment for use in their own classrooms.

These demonstrations were followed by a two-day MRS symposium entitled Communicating Materials Science: Education for the 21st Century, which was attended by about 90 teachers and highlighted the broad range of collaborative endeavors between university researchers and teachers to include materials science in K-12 science classrooms. This NSF-supported symposium was organized by Shenda Baker of Harvey Mudd College, Fiona Goodchild of the University of California at Santa Barbara, Wendy Crone of the University of Wisconsin, and Susan Rosevear of CMSE. Professor Rubner presented a talk entitled "Research Experience for Teachers at MIT: From the Laboratory to the Classroom." The importance of this symposium has been highlighted in both *Nature* (Vol. 432, Dec. 16, 2004, p. 791) and *Nature Materials* (Vol. 4, No. 2, Feb. 2005, p. 105).

Science and Engineering Program for Middle School Students

For the past 13 summers, CMSE has operated a science and engineering program for up to 24 seventh- and eighth-grade students from two Cambridge public schools. The program's objectives are to familiarize the students with the field of materials science and engineering, demonstrate that science and engineering are fun and interesting, introduce students to a college environment, and expose them to some of the exciting resources at MIT. The program consists of a full summer week of hands-on and inquiry-based science and engineering classes for students from each school.

The program covers a wide variety of topics. Most activities take place during 90-minute periods, and most include multiple sessions. The 2004 program consisted of glassblowing, blacksmithing, polymer chemistry demonstrations, constructing a dual sine wave oscillator, building a simple motor, and a design contest. Each year the program concludes with this "shoot-the-hoop" design competition, to which the families of the program participants are invited. CMSE has developed collaborative relationships with MIT's Edgerton Center, the MIT Museum, and the departments of Physics, Materials Science and Engineering, and Electrical Engineering and Computer Science, which contribute to the development of projects and their presentation to the middle school students.

Undergraduate Education

Undergraduate Research Opportunities Program

CMSE continues to sponsor undergraduate involvement in MRSEC research through MIT's Undergraduate Research Opportunities Program (UROP). During the past year, 11 students (including five women and two members of an underrepresented minority group) participated in the program with support from CMSE. In addition to the students paid by MRSEC, 18 undergraduates worked on CMSE research who either were supported by other funds or received academic credit.

Summer Research Internship Program

In collaboration with MPC, CMSE sponsors a Summer Research Internship Program (through the NSF Research Experiences for Undergraduates [REU] program). The program's major goals are to provide undergraduates from other institutions an opportunity to perform cutting-edge materials research and to attract students to graduate studies in materials science and engineering. The two centers intend to continue this collaboration. The program is open to US citizens and permanent residents who will be juniors or seniors the following fall. We receive approximately 150 applications each year, which are reviewed by a committee consisting of the CMSE director and staff from both centers. Participants are chosen from this pool on the basis of academic performance, interest statements, and faculty references. The 15 students accepted into the program for the summer of 2005 included six women and nine men, three of who are from underrepresented minority groups.

The students are paid stipends and work full time for 10 weeks. Most of them live in a dormitory on campus. Weekly meetings are devoted to research discussions and informal seminars with guest speakers on topics such as the graduate school admissions process, research funding, and intellectual property. The interns complete the program by producing posters that report on their summer's research. The resulting poster session is held during the final week and is open to the entire MIT community. It includes posters produced by participants in CMSE's MRET and Roxbury Community College programs as well and serves the dual purpose of serving as a final report by the interns and teachers and informing the broader MIT materials community about the wide range of research being done under the auspices of the two centers.

Diversity Enhancement Activities

CMSE has a history of promoting and encouraging traditionally underrepresented minority groups and women to participate in materials research. This is accomplished through educational outreach efforts, special programs for graduate research assistants, and efforts to coordinate activities with faculty, postdoctoral associates, and graduate and undergraduate students. A few of these activities are summarized below.

Roxbury Community College Partnership

In an attempt to build a relationship with community colleges in the Boston area that enroll a higher percentage of underserved students, we launched a new program in collaboration with Dr. Ray Turner, executive dean of academic affairs at Roxbury

Community College (RCC). The initial phase of this program will establish a formal research experience program for RCC students at MIT. This program began in the summer of 2005 with five RCC students. The overall objectives are to engage community college students in current materials research and to encourage and enthuse them to pursue advanced degrees and careers in science and engineering.

The RCC students spend 10 weeks during the summer working on CMSE research as part of a faculty-led research group, similar to our summer internship program. They attend all of our REU meetings and activities as well. Faculty at RCC assisted in the selection process for this program. Students were chosen on the basis of their interest, academic preparation, and faculty recommendation. To prepare them for this experience, the students completed the RCC lab course Research Techniques in Science. Similar to the summer internship program, the students selected research projects after attending a symposium to learn about the different projects offered, and are paid a stipend. At the end of the summer, participants will present posters on their research at the REU/MRET poster session. CMSE will work with RCC to track these students once they complete the program.

A special feature of this program is that an RCC faculty member has joined a CMSE research group as an MRET participant for the summer. In this capacity, he is furthering his own professional development and, at the same time, is available on campus to mentor and interact with his students.

It should be noted that a CMSE-supported faculty member, Professor Donald Sadoway, has had an informal relationship with RCC for a number of years. For the past six years, working with Ray Turner, Professor Sadoway has placed RCC students in CMSE/MIT research groups during the summer and, in some cases, on a part-time basis during the academic year. By all accounts, this has been a very successful collaboration. CMSE seeks to leverage this success by building a more formal and far-reaching program.

To help jump-start this program, NSF awarded CMSE an additional $25K in supplemental support for MRSEC. This additional funding supports the RCC students and provides a stipend for the RCC faculty member. If this program is successful, with suitable funding, we will expand it to include other minority-rich community colleges in the Boston area in future years.

Enhance Participation by Students from Underrepresented Minority Groups in the REU Program

We plan to enhance participation by students from underrepresented minority groups in the REU program through targeted marketing and the development of potential partnerships with other NSF-sponsored sites. NSF has identified program directors at colleges and universities with historically underrepresented groups on campus. In fall 2004, we mailed 85 introductory letters and brochures about our REU program to these directors, followed by a second letter with student recruitment posters. This is a first step in the longer-term strategy to work with these individuals to increase the number of underrepresented minority students who apply and are accepted into research internships.

In a separate effort to attract minority students to our REU program, the director and education officer presented a table at the New England Board of Higher Education Science Network intern fair last fall. These efforts resulted in a very modest increase in the number of minority students who applied to our REU program for summer 2005. Clearly we will have to develop deeper discussions with faculty and administrators at the identified institutions to significantly impact our pool of applicants.

Educational Outreach Collaborations and Materials Science Content Expansion

Other areas of effort include collaboration with other units at MIT to enhance educational outreach programs and to add materials science content to the programs of other departments and centers. For many years, we have collaborated with the Edgerton Center and MIT Museum on our middle school program, school visits, and Family Adventures in Science and Technology Sundays at the museum. We have established strong working relationships and collaborations with other administrative units at MIT, including MPC and various departments in the schools of Science and Engineering. Recently, we had preliminary discussions with staff of the School of Engineering's Special Programs Office about including hands-on materials science units in the SEED or STEM program. CMSE participated in the Engineering at MIT is Fun Day program for high school students attending the National Society of Black Engineers meeting in Boston in March 2005 by teaching a motor-building workshop to a group of 20 students. In addition, CMSE has participated in discussions of the recently formed Committee on MIT K-12 Educational Outreach led by Professors Eric Klopfer and Kim Vandiver. The center also presented its programs at the MIT K-12 Educational Outreach Midway during the presidential inauguration week festivities.

CMSE has been very successful in offering educational enrichment opportunities to a broad and diverse range of individuals. We continue to enthusiastically support the participation of women and members of underrepresented minority groups in all of our education programs.

Graduate Education

IRGs, initiatives, and seed projects supported by CMSE include research assistantships for graduate students. CMSE provides additional funds to support three full-year and two summer assistantships for graduate students from underrepresented minority groups. Two EECS graduate students are being supported in the summer of 2005. During the coming year, CMSE will fund one graduate student in EECS, one in Physics, and one in Materials Science and Engineering. This targeted funding is supplemental to a faculty member's existing CMSE funds, thus providing incentive to include minority students in his or her research group.

Michael F. Rubner
Director
TDK Professor of Materials Science and Engineering
MacVicar Faculty Fellow

More information about the Center for Materials Science and Engineering can be found online at http://web.mit.edu/cmse/www/.