Our Shared Responsibility for the Future and Health of Materials Research Globally (Part II)

A Return on Investment and the Need for International Cooperation

The discovery of x-rays, and the invention of the electron microscope, enabled the understanding of crystal structure and defects. This facilitated a fundamental understanding of mechanical properties of materials, band structure, and electron transport, among other things. The understanding of Brownian motion came early during the last century (1905) and enabled the understanding of the connection between structure and atomic transport of materials. Throughout most of the 20th century, physics had a profound impact on the development of fundamental materials science. Toward the end of the century, the fields of chemistry and biology paved the way toward new classes of materials (e.g., nanocomposites, hybrid organic–inorganic materials, and biomolecular materials), and new low-temperature processes to synthesize and produce inorganic materials became available; organic electronics became a reality. A long-time dream of engineering the structure—atom-by-atom, molecule-by-molecule, and layer-by-layer—of materials for specific uses became a reality. The big surprise, however, is that totally new, unexpected physical phenomena (e.g., finite size effects, quantum phenomena, universality in critical systems, unusual mechanical properties, and high-temperature superconductivity) as well as remarkable property enhancements emerged. Consequently, new challenges to researchers in theoretical condensed matter, materials physics, and computational physics/materials also emerged.

Materials engineering, materials chemistry, and biomolecular materials will play a more important role in solving major societal problems—from energy and healthcare to the environment—than at any point in history. The rewards from exploiting opportunities at the boundaries between disciplines (e.g., physics, chemistry, and biology) are significant. In a nutshell, the best is yet to come. However, it is not clear in which corner of the globe these breakthroughs will happen. It does not take too much imagination, nevertheless, to realize that with limited research funding, we can bet where they *won't* happen.

Limited science budgets, compounded by political and policy-related questions, social concerns, and—yes—the price of globalization, create complex multifaceted challenges. In this, my second letter in this series, I follow up on the issue of limited research funding and managing finite resources. I will highlight the need for international collaboration and identify the challenges we face as an international materials research community.

"If there were an unlimited budget, how would we know when we had enough funding for materials research?"

The number of proposals submitted to U.S. funding agencies such as the National Science Foundation, the Department of Energy, and the Department of Defense far exceeds the resources available for research. This surge is due mainly to a plethora of new and good ideas that reflect the recent rapid evolution of the field. Thus it is worth asking the following question: If there were an unlimited budget, how would we know when we had enough funding for materials research?

In fact, this is a serious question that is being asked of researchers by policymakers. So, the issue of how we deal with limited resources is an important one. The answer to this question is not simple and we, as a community, have never had to deal with it. To the average educated person, this is an obvious question that all organizations must answer, so why should we be exempt?

The extent to which we manage resources, prioritize projects, and communicate a return on investment to the public and policymakers will, in part, determine our long-term success. Questions regarding prioritization and investment/divestment strategies are interesting, yet vexing, in a rapidly evolving field such as ours. It will be important for us to identify and develop indicators to quantify (i.e., benchmark) issues related to the impact of science and to communicate them to non-materials researchers. The brief "snapshot" of the progress in the field, mentioned heretofore, heightens our anxiety. The number and scope of the proposals requesting funding from agencies reflect the excitement in our field. The evolution of our field is also reflected in the number of new niche journals on materials, and the redirected focus on materials in other journals. What criteria do we use to identify areas of emphasis? With limited budgets, how can we develop investment/divestment strategies to prioritize spending on critical areas of materials research? When we prioritize, how do we account for potential science/technology surprises that may be missed in the future? I fully admit that I do not have the right answers, but we need to address these questions.

I now comment on the funding issue within the global context. Because of the successes arising from government investment in research during the latter part of the 20th century, we are in what is often referred to as a "knowledge-based economy," wherein the commercial and intellectual value of research output plays a critical role in driving the economy. This, in fact, is a significant part of the equation regarding the return on investment. This also appears to drive the long-term research investment strategies of a number of governments around the world. A cursory analysis of the number of papers published in technical journals indicates that the basic research investment around the globe is significant! Technical leadership in some areas of our discipline, while largely residing here in the United States, is rapidly growing in Asia (particularly Japan, China, and South Korea) and Europe. One publication that examined materials research and development (R&D) globally is a National Research Council report, "Globalization of Materials R&D: Time for a National Strategy." The study was performed under the auspices of the National Materials Advisory Board in the

United States and discusses the status of materials science and engineering R&D in the States and the rest of the world and its economic impact. While the report discusses the concern of U.S. leadership in materials R&D, it presents important facts that support the notion that excellent research is done in many places around the world. Private entities have known this for some time, and one of the consequences of globalization is that non-U.S. companies invest billions of research dollars in the United States for R&D, as do U.S. companies elsewhere, outside the United States (see Globalization study).

Future dominance in key areas of science and technology could reside in any region of the globe. Government investments in research will fluctuate, regardless of where one resides. Researchers will be more mobile than before. Private entities will always support research, anywhere in the world. So perhaps the real question, in light of the foregoing assessment of limited resources, is how do we, as materials researchers located around the world, play together constructively? Opportunities to leverage resources in science through collaborations among MRS and technical societies around the world that do materials research will provide more significant progress than at any point in history. Unfortunately, one challenge we face is that just as companies necessarily protect intellectual property to safeguard their futures, many countries around the world would do the same. So, the extent to which governmental policies influence not just funding trends but also how technical information is exchanged is uncertain. Therefore, with all that has been said and the uncertainty of how future events unfold and the unpredictability of human decision-making, one can be sure of one thing: Innovations in science and engineering will continue with or without government investment in science. The only uncertainty is whether a sufficiently large number of people will be aware of the developments and share the benefits and excitement.

PETER F. GREEN
2006 MRS President

MRS Awards

DEADLINE for Nominations—
June 1, 2006

It's Not Too Early to Think About the MRS Awards Program!

The MRS Awards Program acknowledges outstanding contributors to the progress of materials research, and recognizes their exciting and profound accomplishments. A variety of awards are offered to honor those whose work has already had a major impact in the field, those who have defined the frontiers of the field, and those who are outstanding exponents of their science.

VON HIPPEL AWARD

The Von Hippel Award, the Society's highest honor, recognizes those qualities most prized by materials scientists and engineers—brilliance and originality of intellect, combined with vision that transcends the boundaries of conventional scientific disciplines. Presented annually at the MRS Fall Meeting, and named in honor of its first recipient, the Von Hippel Award includes a cash honorarium and a unique trophy—a mounted ruby laser crystal symbolizing the many-faceted nature of materials science.

DAVID TURNBULL LECTURESHIP

The purpose of this lectureship is to recognize the career of a scientist who has made outstanding contributions to understanding materials phenomena and properties through research, writing, and lecturing, as exemplified by the life work of David Turnbull. It also provides lectures of exceptional quality and scientific significance for the MRS Fall Meeting as well as, possibly, MRS Section and University Chapter meetings. Recipients of this award receive a cash honorarium and a citation plaque.

MRS MEDAL AWARD

MRS Medals are intended to constitute public and professional recognition of outstanding recent achievements in materials research. An engraved medal and citation certificate are awarded, along with a cash honorarium, for a specific discovery or advancement which is expected to have a major impact on the progress of any materials-related field.

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For more information on the MRS Awards Program and the nomination procedure, visit

www.mrs.org/awards/

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