



PRETORIA, SOUTH AFRICA

6 - 9 August 2000

## Preface

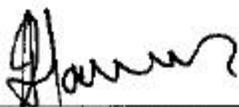
### Toward Greater International Cooperation in Materials Research

Materials are more than mere components in technology; rather, the basic properties of materials frequently define the capabilities, potential, reliability, and limitations of technology itself. Improved materials and processes will play an ever increasing role in efforts to improve energy efficiency, promote environmental protection, develop an information infrastructure, and provide modern and reliable transportation and civil infrastructure systems. Advances in materials science and engineering, therefore, enable progress across a broad range of scientific disciplines and technological areas. Indeed, effective and sustainable use of materials is critical for the well-being of society.

Continued progress in materials science and engineering is increasingly dependent upon collaborative efforts between several different disciplines, as well as closer coordination among funding agencies and effective partnerships involving universities, industry, national laboratories, and other research organizations. In addition, because of the rapidly growing interdependence of the world's economies, partnerships are not only important at the national level but from an international point of view as well.

With this in mind the National Research Foundation of South Africa, the Ministry of Environment, Science, and Technology of Ghana, the Commission of Higher Education of Kenya, the Raw Materials Research and Development Council of Nigeria, the Ministry of Higher Education and Scientific Research of Senegal, the Tanzania Commission for Science and Technology of Tanzania, the Ministry of Higher Education and Technology of Zimbabwe, and the National Science Foundation of the United States co-sponsored a workshop in the area of Material research designed to help stimulate enhanced collaboration among materials researchers and create networks linking the participating countries. The workshop was held on August 6 - 9, 2000 in Pretoria, South Africa, and was attended by eminent scientists and engineers from Botswana, Egypt, Ethiopia, Ghana, Kenya, Lesotho, Morocco, Namibia, Nigeria, Senegal South Africa, Swaziland, Tanzania, United States, Zambia, Zimbabwe. Their excellent report is attached. We would like to thank all workshop participants and in particular the workshop coordinators Aboubaker Chédikh Beye, Senegal; Robert P. H. Chang, United States; Arthur Every, South Africa; Joseph O. Gogo, Ghana; Frank P. L. Kavishe, Kenya; Marjorie Mujaji, Zimbabwe; E. r. Sadiku, Nigeria; Ron Sanderson, South Africa; Joseph V. Tesha, Tanzania; A. J. Varkey, Swaziland; and Isiah M. Warner, United States for the Considerable effort that went into organizing the workshop and preparing the report.

From time to time we expect to communicate with the materials research communities in the African countries as we jointly work toward implementation of the recommendations contained in the workshop report.



Jill Sawers, South Africa



Edwin Barnes, Ghana



Justin Iriga, Kenya



Ademola. Ajibade, Nigeria

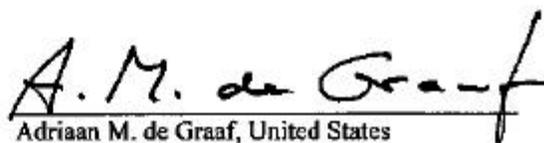
for   
Madior Diouf, Senegal



Yadon M. Kohi, Tanzania



Michael Ngoni Mambo, Zimbabwe



Adriaan M. de Graaf, United States

## Background

The first U.S.-Africa Materials Workshop was held at the Farm Inn in Pretoria, South Africa from Sunday, August 6, to Wednesday, August 9, 2000. The event was sponsored by the National Science Foundation (NSF) and the National Research Foundation (NRF) and supported by the scientific agencies of the participating countries. A planning meeting, attended by the workshop organizers and representatives from the NSF and NRF, was held at the National Research Foundation in Pretoria, South Africa on July 27 and 28, 1999. During this meeting, the organizers identified the following goals for the workshop:

- To identify specific areas and future directions for fruitful U.S.-Africa cooperation in the interdisciplinary field of materials research and education
- To establish an electronic network on materials science and engineering for these regions
- To recommend how the supporting U.S. and African government agencies can help in the development of increased cooperation in the international research community, especially between the United States and Africa

The 68 workshop participants were from Botswana, Egypt, Ethiopia, Ghana, Kenya, Lesotho, Morocco, Namibia, Nigeria, Senegal, South Africa, Swaziland, Tanzania, the United States, Zambia, and Zimbabwe. An observer from the United States, along with representatives from the National Science Foundation and the National Research Foundation, brought the total number of people attending the workshop to 81. The workshop organizers were:

A.C. Beye	Senegal
Robert P.H. Chang	United States
Arthur Every	South Africa
Joseph O. Gogo	Ghana
Frank P.L. Kavishe	Kenya
Marjorie Mujaji	Zimbabwe
Emmanuel R. Sadiku	Nigeria
Ron Sanderson	South Africa
Joseph V. Tesha	Tanzania
A. Joseph Varkey	Swaziland
Isiah M. Warner	United States

## Workshop Topics

The workshop explored research opportunities directed towards expanding materials research and education for the purpose of contributing to the development of new technologies as well as promoting collaboration among U.S. and African universities and industries. Focus groups addressed the following topics:

- Education and training
- Civil infrastructural materials (e.g., construction, concrete)
- Materials characterization (modeling, low-cost instrumentation, NDT)
  - Materials value chain (raw materials to processed products)
  - Biomass/natural products
  - Minerals/ores/metals
  - Indigenous materials

- Affordable health care
- Advanced and emerging materials (niche opportunities for Africa)
  - Advanced polymer synthesis
  - Photonic and electronic materials
  - Nanomaterials
  - Advanced ceramics

The agenda for the meeting is shown in Appendix 1.

The opening ceremony of the workshop was held on August 6, 2000. The following speakers welcomed the participants:

- Alhaji Abubaker Abdullahi, Director-General/Chief Executive, Raw Materials RandD Council, Nigeria
- Edwin P.D.Barnes, Chief Director, MEST, Ghana
- Joseph Bordogna, Deputy Director, NSF, U.S.
- Gerhard von Gruenewaldt, Vice President, NRF, South Africa
- Justin Irina, Secretary, Commission for Higher Education, Kenya
- Yadoni Kohi, Director General, Tanzania Commission for Science and Technology, Tanzania
- Michael Ngoni Mambo, Permanent Secretary, Ministry of Higher Education and Technology, Zimbabwe
- Moustapha Sourang, Rector of UCAD, Senegal

The first day of the workshop featured plenary lectures representing the topical areas of the workshop. The workshop also featured a panel discussion on applications of polymers and composites. The talks and the panel discussion set the tone for the discussions of the following day.

On the second day of the workshop, seven groups in each of the topical areas met in parallel sessions to discuss in detail some of the issues and questions that were introduced during the plenary talks. Specifically, the groups sought to identify links between the research and technology topics and materials needs, resource issues, manufacturing technology issues and materials education. The groups identified potential joint materials research topics with long-term, global benefits, addressed human resource issues, and discussed the central role of communication in collaborative efforts. In addition to identifying regional research strengths, infrastructure issues, and educational issues, the groups considered how existing relationships and potential connections among universities, national laboratories, industries, and funding agencies might promote collaborative initiatives.

On day 3, the groups presented their reports in a plenary session, which allowed all workshop participants to contribute to the workshop report.

### **Workshop Conclusions**

Working within the topical areas, the workshop participants collectively offered many suggestions for launching collaborative ventures that would promote materials research and education in the U.S. and in Africa. Records of their discussions, along with their recommendations, appear in full in the appended reports. One common thread throughout all of the topical groups' discussions was the need to establish one or more organizations to ensure

the continuation of the conversations and initiatives that began at this workshop. The current fragmentation of the African materials research community is a serious obstacle to African progress in the area of materials. A continent possessed of tremendous potential wealth in the form of its natural resources, Africa too often finds itself without the necessary funds and human resources to enjoy its own riches. The formation of an African Materials Research Center and/or other materials-related consortia or centers would help to foster and coordinate efforts to obtain funding and to retain expertise within Africa while simultaneously attracting high-powered scientific and industrial collaborators from abroad. Given the barriers of time and distance that separate African nations from each other and the rest of the world, greater use of the Internet was also encouraged by all of the discussion groups. Whether it is used simply for communication or for sophisticated research projects involving the remote control of instrumentation, all groups agreed that the World Wide Web ought to be exploited in the service of improved collaboration among materials scientists working in academe, industry, and government. Similarly, many groups recommended the establishment of databases that would provide all materials scientist with a base from which to network with colleagues in their region, nation, and around the world.

### **Technical Recommendations**

The recommendations made by the topical group in Materials Education and Training included the formation of consortia—at the regional, national, and continental levels—that could set international benchmarks for quality in research, teaching, and facilities. These consortia would also establish a common core curriculum in materials science. The group cited the need for the development of courses and curricular modules emphasizing industrial applications, which could be used at the precollege, undergraduate, and graduate levels. Graduate fellowships from industry would be more prevalent, the group reasoned, if industry had greater representation on departmental committees. In order to maximize the use of available education and training resources in materials, the group recommended the creation of a website. This website could be part of a larger initiative, such as the proposed U.S. Africa Institute of Materials Research and Education, which would strengthen the relationship of materials scientists and engineers working in the U.S. and throughout Africa. An institute such as this one would utilize existing resources, both government-owned and within the private sector, to set up partnerships between the U.S. and different regions of Africa. This institute would help U.S. academics to become involved in research and education in Africa, and vice versa. Ultimately, such a venture would prove mutually beneficial to the U.S. and to Africa.

The group for Civil Infrastructural Materials agreed that focused materials research and development efforts are needed in the design and construction of the following: durable infrastructural materials, energy efficient housing, and materials for road and transportation infrastructure development. Most crucial for Africa is the need for research into ways to create aesthetically appealing and socially acceptable low-cost housing materials. The recognition of this goal will require integrated, multidisciplinary research and development that is informed by the expertise of civil and mechanical engineers, architects, and materials scientists and engineers. Obstacles to the creation of decent, low-cost housing include a lack of funding and a dearth of high-level materials science personnel within many regions of Africa. One way to remedy this latter problem, the group suggested, would be to form a database, possibly under the auspices of the nascent Africa MRS, of all available human resources within Africa in the area of materials science and engineering. Similarly, some members of the group proposed the publication of a journal (perhaps only on the web, in order to minimize costs) of the Africa MRS, which would encourage still more collaborative ventures. This topical group plans to continue communicating with one another via the web in order to complete some or all of the following

tasks: joint proposal development, collaborative research and code development, and joint organization of symposia or workshops that will be part of future Africa MRS meetings or other, similar meetings.

The materials characterization group proposed the formation of an African Materials Characterization Consortium in order to integrate existing and future characterization techniques and facilities and to provide a permanent staff for their efficient utilization. They also recommended the establishment of an African Materials Research Society, which would facilitate the use of advanced information technology and promote materials education at all levels, from K-post graduate. This organization might also be able to reverse the industry's tendency to perform research outside of Africa and to deliver turnkey processes and factories. The group also recommended that international offset agreements be reached in order to change this trend.

Two topical groups met on the subject of the Materials Value Chain. The groups acknowledged the great variety of value chains abounding on the African continent, noting that opportunities for economic growth, job creation, and global competitiveness inhere within the varied materials industries. In order to recognize these improvements, one group proposed a dual focus for research: first, into the identification and development of better materials and second, into alternate manufacturing processes that will impart added value to materials. Greater use of the Internet, including cross-linked web pages among institutions with an African focus, as well as the formation of an Africa MRS, were recommended as means by which to achieve these goals. The other group recommended the establishment of value chain subcommittees that would systematically work a) to enhance middle level technical training that was focused on specific value chains and b) to promote the targeted education of workers in the areas of emergent technologies.

Two groups discussed Advanced and Emerging Materials. The development of products such as photovoltaics, photoconcentrators, optical materials, biomaterials for medical applications, polymer fibers and ultrahard materials can best be facilitated in a number of ways. Specifically, African institutions need to acquire laboratory equipment that they can also repair and to develop foundations that will fund collaborative research. If these recommendations can be implemented, they may stop the "brain drain" out of Africa. The groups recommended internet-accessible libraries with electronic journal subscriptions and the establishment of an African Materials Research Society. One group's recommendation for the establishment of regional centers of excellence dedicated to particular areas of research was echoed by the other group's fully-fleshed-out plan to create regional Centers for Advanced Technology and Entrepreneurial Development (CATED). As envisioned, these centers will act as hubs for collaboration, attracting renowned scientists who will be able to work together using state-of-the-art equipment located on site. These centers would allow young African scientists to flourish in their fields rather than to feel compelled to leave Africa in order to advance their research efforts.

## **Acknowledgments**

The workshop organizers gratefully acknowledge the government agencies that supported the participants. The representatives of Reynolds Travel Agency—Lydia Norval, Mary Reynolds, and especially Jenny Hutchinson—worked tirelessly to assist the participants with all of their travel and lodging arrangements. Ron Sanderson of the University of Stellenbosch procured tote bags for all of the participants at no cost. Yunus Ballim of the University of the Witwatersrand prepared the report of Thursday's technical meeting, which is included in appendix 4. Christine Belden compiled the final report and served as the primary workshop coordinator for the U.S. and African participants. Finally, Jill Sawers' staff at the NRF—especially Nicoli Thomas, Jenny Hale, and Francisca Howie—provided invaluable organizational assistance during, before, and after the workshop.