

## CONFERENCE REPORTS

# HTC-2004 Sees Advances in Capillary Phenomena in High-Temperature Materials

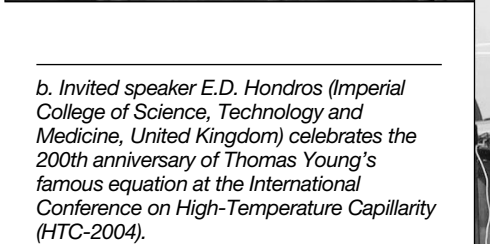
The International Conference on High-Temperature Capillarity (HTC-2004) was held March 31 to April 3, 2004 in San Remo, Italy, under the auspices of the Italian National Research Council (CNR) Institute for Energetics and Interphases. The conference was opened by the 1991 Nobel Laureate in Physics, Pierre-Gilles de Gennes, of the Collège de France in Paris, who presented a lecture on the interpretation of a wide spectrum of capillary phenomena including dewetting, nonwetting, reactive wetting, and spreading and their relation to the intrinsic molecular characteristics of the different phases in contact, thus making the bridge to the “low-temperature” wetting community.

The conference commemorated the 200th anniversary of Young’s publication of the relationship that defines the wetting angle (The Royal Society, December 1804), with a historical retrospective by E.D. Hondros (Imperial College of Science, Technology and Medicine, United Kingdom), titled “Thomas Young, Natural Philosopher,” and a dedicated session covering highlights of the application of Young’s equation in high-temperature capillarity.

Within a format of a single venue for all presentations, with no parallel sessions, the conference presented topics that ranged from fundamental capillary science, where both old and new ideas and data were presented in a relevant context, to practical process-related applications involving high-temperature wetting and joining phenomena in metals and ceramics. Some of the new experimental techniques—especially high-resolution electron microscopy, including grain boundaries and the impressive atomic-resolution movies of the tips of advancing wetting films at surfaces—provided insight into phenomena at heterogeneous interfaces formed by the wetting of dissimilar materials.



a. Nobel Laureate P.-G. de Gennes (Collège de France, Paris) delivers the opening lecture at the 2004 International Conference on High-Temperature Capillarity (HTC-2004).



b. Invited speaker E.D. Hondros (Imperial College of Science, Technology and Medicine, United Kingdom) celebrates the 200th anniversary of Thomas Young’s famous equation at the International Conference on High-Temperature Capillarity (HTC-2004).

Since the last HTC conference in 2000, there has been a significant increase in presentations on capillary phenomena at grain boundaries, a topic in high-temperature capillarity that has many important ramifications in materials science such as liquid-metal or grain-boundary embrittlement phenomena. Moreover, the coverage of the basic science of capillarity at high temperatures was coupled with discussions of technological problems such as the relevant studies on the role of the dynamic transfer of oxygen from the gaseous phase to the liquid-metal surface on the surface

tension of liquid metals and the effects of Marangoni convection on welding pool shape. The conference benefited from the participation of theoretical groups modeling problems such as contact angles at metal/ceramic interfaces, surface melting, and metal/ceramic interfacial energies. The modeling efforts presented were very impressive: The predictive power of some thermodynamic and kinetic models has reached the point where some HTC experiments can be replaced, at least in part, by simulations.

Important studies were also been presented on new experimental techniques (in particular, an apparatus for measuring the surface tension and related properties of liquids by a new zero-gravity technique), on the wettability and joining of special ceramics (e.g., borides, nitrides, and carbides), and on the effects of roughness on contact angles. The importance of dynamic phenomena in the analysis of high-temperature behavior of molten materials (so-called real-time tests) was addressed.

With the attendance of more than 130 scientists from 19 countries, the international flavor of this conference gave a sense of just how geographically broad this highly focused field has become.

### Topics of particular interest at the 2004 International Conference on High-Temperature Capillarity included:

- Capillary properties of high-temperature systems:
  - Liquid surfaces of metals, glasses, and salts; surface energy and adsorption; grain boundaries; intergranular films;
  - Metal-metal, metal-ceramic, metal-glass, and ceramic-ceramic interfaces: wettability, adhesion, interfacial reactions and diffusion, segregation;
  - Capillarity in crystal growth, grain growth, and solidification;
  - Capillarity in microgravity;
  - Marangoni phenomena;
  - Corrosion and embrittlement by liquid metals; and
  - Electro-capillarity and associated phenomena.
- Capillarity in materials processing (foundry processes, composite materials).
- Joining by brazing and welding.
- Advances in measurement techniques of capillary properties.

Moreover, the combination of applied and fundamental research presentations enables participants to understand basic phenomena, solve problems in processing, and address new questions.

The papers presented at this conference will be published in a dedicated volume

of the journal *Interface Science*.

HTC-2004 was endorsed by Genova04, the Materials Research Society, and the Italian Institute of Welding.

The next High-Temperature Capillarity conference, organized by Enrique Louis (e-mail: enrique@fisc1.ua.es), will be held

in Alicante, Spain, in 2007. The first three meetings were held in Smolenice, Slovakia, in 1994; Cracow, Poland, in 1997; and Kurashiki, Japan, in 2000.

ALBERTO PASSERONE  
Chair, Organizing Committee

## NDSI 2004 Highlights Emergence of Devices and Systems Resulting from Nanotechnology Initiatives

The inaugural Conference on Nanoscale Devices and System Integration (NDSI 2004) was held in Miami, Fla., February 15–19, 2004. The focus of the conference was “real-life” devices and systems that have recently emerged as a result of nanotechnology initiatives in chemistry and chemical engineering, physics, electrical engineering, materials science and engineering, biomedical engineering, computer science, and robotics, among other disciplines. The conference had a single-session, all-invited-speaker format. Contributed work was showcased at a special poster session. The conference, sponsored by the Institute of Electrical and Electronics Engineers (IEEE) and the U.S. Air Force, was co-organized by the teams of the Center for Nanoscale Magnetic Devices (CNMD) of Florida International University (FIU) and the Center for Nanomagnetic Systems (CNS) of the University of Houston. The conference drew more than 160 participants from 14 countries. To strengthen the connection between fundamental research and “real-life” applications, the conference featured a large number of presenters both from academia and industry. Among the companies represented by industrial researchers presenting their latest work in the field were NEC, IBM, Toshiba, AMD, Samsung, Seagate, and Veeco.

Nanotechnology generated a wave of research collaborations between scientists from academia and industry with a broad range of specializations. Such a global approach resulted in a number of accomplishments. Sakhrat Khizroev (conference co-chair, CNMD/FIU) said, “One of the main goals of this conference is to identify these accomplishments and put on the map the novel technology initiatives and the emerging research teams.”

A highlight of the conference was the announcement of a protein-based memory device capable of recording information with an areal density above 10 terabit/in<sup>2</sup>. This technology was developed jointly by researchers at FIU, the University of Houston and Harvard University. The protein-based media



Students, professors, and industry researchers share their ideas at an NDSI 2004 poster session.

used in this demonstration were genetically engineered in the research group of V. Renugopalakrishnan of FIU and Harvard.

To emphasize the role of magnetic applications in nanotechnology, a separate session was dedicated to extensive discussion of nanoscale magnetic devices. As noted by Dmitri Litvinov (NDSI co-chair, CNS/Univ. of Houston), “Magnetic technologies pioneered the transition to nanoscale with the current state-of-the-art demonstrations in the range of 60 nm × 60 nm characteristic cell size, rapidly scaling to the sub-10 nm domain.”

Representatives from manufacturers such as Seagate and Motorola, and from the University of Chicago—Illinois, the University of Twente, and the University of South Florida, among others, presented their latest results in areas of magnetic recording, magnetoresistive random-access memory (MRAM), nanoscale magnetic metrology, and other areas.

As a tribute to the role of carbon nanotubes (CNTs) in nanotechnology, the first technical session was dedicated to

CNT-based devices and applications. This session opened with a review of the latest accomplishments in the field by M. Meyyappan, director of the NASA Ames Research Center for Nanotechnology. In this session, P. Avouris, manager of the Nanoscale Science and Technology group at the IBM T.J. Watson Research Center, demonstrated CNT-based transistors with superior electronic properties. J. Sone of NEC Corp., Japan, presented the industry perspective on CNT device development.

The CNT session was followed by sessions on quantum computing, nanophotonics, nanoelectronics, and nanomagnetism. As an important accomplishment in an emerging field of quantum computing, three-dimensional (3D) self-consistent simulation of spin-qubit quantum dots and circuits was demonstrated by J.-P. LeBurton of the University of Illinois at Urbana-Champaign. In the field of nanophotonics, M. Lipson of Cornell University demonstrated how light can be controlled in a nanoscale device. D. Weller of Seagate Research presented an up-to-date account

of nanomagnetic developments in magnetic data storage, including self-organized magnetic arrays and heat-assisted magnetic recording. V. Baranauskas of Universidad Estadual de Campinas, Brazil, demonstrated high-performance nanoscale field-emission devices based on diamondlike materials.

Several presentations were dedicated to nanoscale fabrication, metrology, and characterization. The sessions were opened by S.Y. Chou of Princeton University, who talked about nanoimprint lithography as an enabling engine for nanotechnology. R. Ruoff of Northwestern University demonstrated scanning probe microscopy with CNT-based tips. J. Wolfe of the University of Houston presented results on high-density sub-4-nm device fabrication using atom-beam array lithography.

One day of the conference was dedicated to molecular electronics, nanoscale biology, and bioengineering. G. Bernstein of the University of Notre Dame opened the day with his talk on nanolithography for molecular electronics. H. Mizuseki of Tohoku University discussed the feasibility of single-molecule electronic devices. Nanoscale molecular electronic devices such as transistors and diodes were demonstrated by D. Janes of Purdue Uni-

versity, V. Subramanian of the University of California, Berkeley, D. Natelson of Rice University, and others. In the same session, H. Hess of the University of Washington showed how naturally occurring biological motors could be used as components in nanoscale electronic devices. G. Finkelstein of Duke University and R. Rinaldi of the University of Lecce, Italy, presented their experimental results on DNA-based periodic self-assemblies, which can be used to build future electronic devices. C.-K. Loong of Argonne National Laboratory demonstrated how proteins and other biological nanotechnology-related materials could be characterized using advanced neutron scattering techniques. Among other results shown for the first time at the conference, G. Whitesides of Harvard University illustrated how biological organisms can generate magnetic fields and gradients necessary for future electronic devices.

One session was dedicated to next-generation devices that rely on nanoelectromechanical systems (NEMS). E. Eleftheriou of IBM Zurich Research Center showed pioneering results on how NEMS-based storage devices could be controlled to accommodate terabytes of data. T. Lebrun of the National Institute of Standards and

Technology (NIST) proposed an optical manipulation of nanocomponents to assemble nanoscale devices.

During the final evening of the conference, a special panel session on "Research and Funding in Nanotechnology" was held jointly by IEEE and funding agencies such as the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), and Semiconductor Research Center (SRC). R. Khosla (NSF), L. Manchanda (SRC), and E. Rashba (IEEE) answered questions from the audience on the latest research directions and opportunities and future standards and regulations in nanotechnology.

NDSI 2004 was endorsed by the Materials Research Society (MRS). The NDSI 2004 advising committee received support from O. Mohammed (FIU), chair of the Miami section of IEEE.

Selected papers presented at the conference are to be published in a special October issue of *Nanotechnology*. The next NDSI conference is scheduled for Houston, Texas, on April 5–6, 2005. Details can be found on the conference Web site at [www.nanointernational.org](http://www.nanointernational.org).

SAKHRAT KHIZROEV AND  
DMITRI LITVINOV

NDSI 2004 Conference Chairs

## International Conference of the African Materials Research Society Focuses on Building Partnerships

Attendees of the 2nd International Conference of the African Materials Research Society (Africa-MRS) interacted across disciplines while also finding opportunities to focus on their area of specialization. Held at the University of the Witwatersrand (Wits) in Johannesburg, South Africa, December 8–11, 2003, the program was designed to enable researchers to build international collaborations for excellence in materials research in Africa.

The conference set aside half of the morning on Wednesday, December 10, for strategic discussions of collaboration in research fields that had been identified by delegates during the conference. The afternoon of the same day was reserved for an Africa-MRS business meeting to plan the next phase of the development of the Society, which was founded in 2002. On December 11, site visits were arranged to materials research facilities at Wits as well as the University of Pretoria and the Council for Scientific and Industrial Research campus in Pretoria.

Close to 200 delegates attended the conference, of which 53 delegates were from outside South Africa. Attendees came

from 24 countries, including 17 countries in Africa. The plenary presentations offered broad overviews of materials research and development, with a view toward stimulating new research directions and opportunities for cross-border and cross-disciplinary collaborations. Technical sessions ran parallel symposia on infrastructure materials, hard metals and coatings, optical properties and characterization, and composites, among other topics. The poster sessions provided a forum for networking and discussions on collaboration. The list of speakers and topics can be accessed at the conference Web site [www.wits.ac.za/AfricaMRSconf2](http://www.wits.ac.za/AfricaMRSconf2).

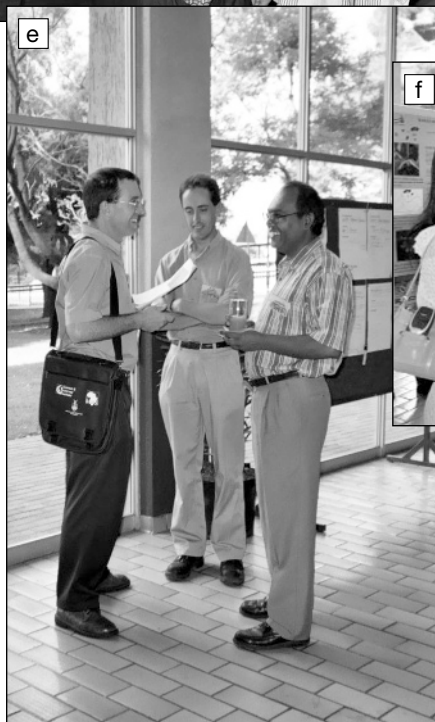
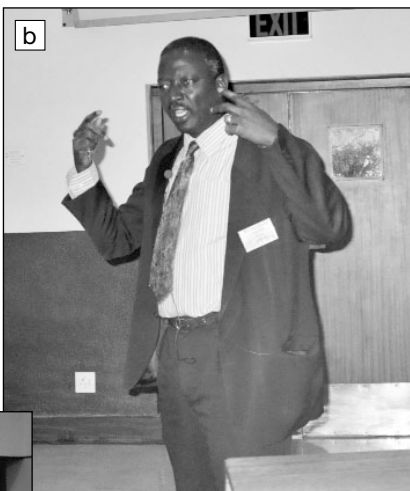
The plenary presentations during the morning sessions of the conference were particularly insightful. Speakers included W.O. Soboyejo from the Materials Institute at Princeton University, who spoke on "Building Partnerships for US/Africa Research in MEMS/Bio-MEMS and Nanotechnology"; T. Kishi, head of the National Institute for Materials Science in Japan, who spoke on "Japanese Strategy of Nanotechnology and Materials Research and NIMS Activity"; F.R.N. Nabarro of the

School of Physics at Wits, who presented a review paper entitled "Power-Law Creep"; and A. Paterson, deputy director general of the South African Department of Science and Technology, who spoke on "Collaboration in Materials Research for Growth in Africa: Challenges and Opportunities."

A feature of the conference was that delegates nominated themes for materials research collaboration. The second session on Wednesday morning was then allocated for strategic discussions (in workshop mode) on these themes, with conveners selected to focus the discussions toward developing future collaborations and partnerships. The following themes emerged from the conference:

- Strong materials (e.g., hard metals, ceramics, and tribology); convener: D. McLachlan (Wits University, South Africa)
- Cement-based materials; convener: Y. Ballim (Wits University, South Africa)
- Computational materials science; convener: N. Chetty (University of Natal, South Africa)
- Materials science education; convener: E. Banda (Makerere University, Uganda)
- MEMS fracture and fatigue; convener:

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(a) Yunus Ballim (right) of the University of the Witwatersrand (WITS), chair of the conference organizing committee and 2003–2004 Africa-MRS president and Ratnam Paskaramoorthy of WITS. (b) Aboubaker Beye (Université Cheikh Anta Diop, Senegal) gave the keynote address on building research collaboration in Africa. (c) Robert Kriger (right) of the South African National Research Foundation presented the address during the conference banquet. Here he converses with plenary speaker Frank Nabarro of the University of the Witwatersrand. (d) Plenary speaker Silvana Luyckx (University of the Witwatersrand) reviews the development of research in hard metals at her institution. (e, f, g) Attendees enjoy opportunities to converse between sessions, during the poster session, and at the banquet.

R. Tait (University of Cape Town, South Africa)

- Minerals and materials/earth sciences engineering; convener: K. Osseo-Asare (The Pennsylvania State University)
- Lasers and materials research; convener: A. Beye (Université Cheikh Anta Diop, Senegal)
- Nonconventional materials; convener: J. Tesha (University of Dar es Salaam, Tanzania)
- Materials for energy and the environment; convener: M. Sassi (Ecole Nationale d'Ingenieurs, Tunisia).

Individuals and regional chapters were encouraged to sustain and develop opportunities for research collaborations emerging from the conference; the chapters are to host regional meetings during 2004. There was also a sense that three or four “research thrusts” should be identified as areas for focused research attention in Africa. Preliminary proposals for these “thrusts” were

- Metals and minerals processing and beneficiation,
- Energy materials, and
- Infrastructure materials.

Regarding organizational and structural arrangements for the next phase of Africa-MRS, a number of decisions were made. The North African Chapter will organize the next conference, scheduled for late 2005 in Morocco. The current executive committee will remain in office until that next meeting. In the interim, the executive committee is to formalize a constitution for the organization by the end of 2004 and put into place the necessary arrangements and structures to allow Africa-MRS to join the International Union of Materials Research Societies as a full member organization.

Delegates also heard from visitors outside the African continent in terms of building partnerships. C. Huber reported developments in the U.S. National Science Foundation on strategies for funding collaborative projects between U.S. and African researchers. E.L. Fleischer from the Materials Research Society (MRS) and editor of *MRS Bulletin* described initiatives and opportunities for collaboration and support between the two professional societies.

Intentions of the conference theme—building partnerships with excellence—were realized, according to the organizing committee. Delegates interacted positively, and a number of new ideas for future research and collaboration emerged from the formal presentations and the informal networking conversations. The conference provided an impetus to the Africa-MRS in meeting its challenge of strengthening and consolidating materials research and development in Africa.

YUNUS BALLIM  
President, MRS-Africa