CERAMIC-MATRIX COMPOSITES: WWW-BASED COURSEWARE AND MORE

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Introduction

A senior-level undergraduate course, entitled "Introduction to Ceramic Matrix Composites," and an introductory graduate-level course, entitled "Ceramic Matrix Composites: Materials and Mechanics," have been recently developed at the University of Tennessee (UT), Knoxville. Both courses, cross-listed under Department of Materials Science and Engineering and Department of Mechanical and Aerospace Engineering and Engineering Science, are interdisciplinary in nature and are available as technical electives for all engineering students at UT.

WWW-Based Courseware

A well-written textbook on ceramic-matrix composites is presently not available since the technology breakthrough in ceramic-matrix composites did not come until about twenty years ago. The research results on the processing, characterization, modeling, and applications of ceramic-matrix composites are published in a wide variety of journals, conference proceedings, and reports. Thus, the learning and teaching of such innovative subject matters is extremely challenging. In recent years, however, modern computer technologies, such as *hypermedia* (i.e., hypertext techniques incorporated with multimedia resources), open a new avenue to the effective learning and teaching. For example, when students read on-line hypermedia documents, they can click key subjects or key words for computer-activated cross references that contain detailed information about the topic the students just selected. This will enable the students to quickly access the desired information rather than thumbing through several journals, conference proceedings, and/or reports on their desks. The selected information may be implemented locally by instructors or generated, on Internet, by other professionals. This format of instructional presentation further provides a wider variety of the types of information that can be presented (for example, multimedia and/or interactive delivery). In addition, it provides a permanent record of the lecture/discussion that can be retrieved/reviewed by the student as well as instructors for further clarification and modification.

As the present curriculum on ceramic-matrix composites is being developed under the support of National Science Foundation's Combined Research-Curriculum Development (CRCD) Program, multimedia and interactive courseware has been implemented simultaneously on World Wide Web (WWW); Figure 1. The courseware, located at http://www.engr.utk.edu/~cmc, consists of (1) instructors' handout in the form of text, color three-dimensional figures, and color pictures, (2) animation/simulation, (3) short video clips with audio effects, (4) homework/exercises, (5) on-line teaching evaluation forms, (6) syllabi, and (7) papers and reports on the progress of the present CRCD project.

In traditional instructional presentations, schematic diagrams are drawn on blackboards and samples and micrographs are circulated among students in the classroom. The present WWW-based courseware, on the other hand, includes three-dimensional figures and color pictures that provide unambiguous explanation and are easy to be retrieved. Computer animation/simulation further helps illustrate continuously changing phenomena, for example, the damage evolution in fiber-reinforced ceramic-matrix composites subjected to tension.

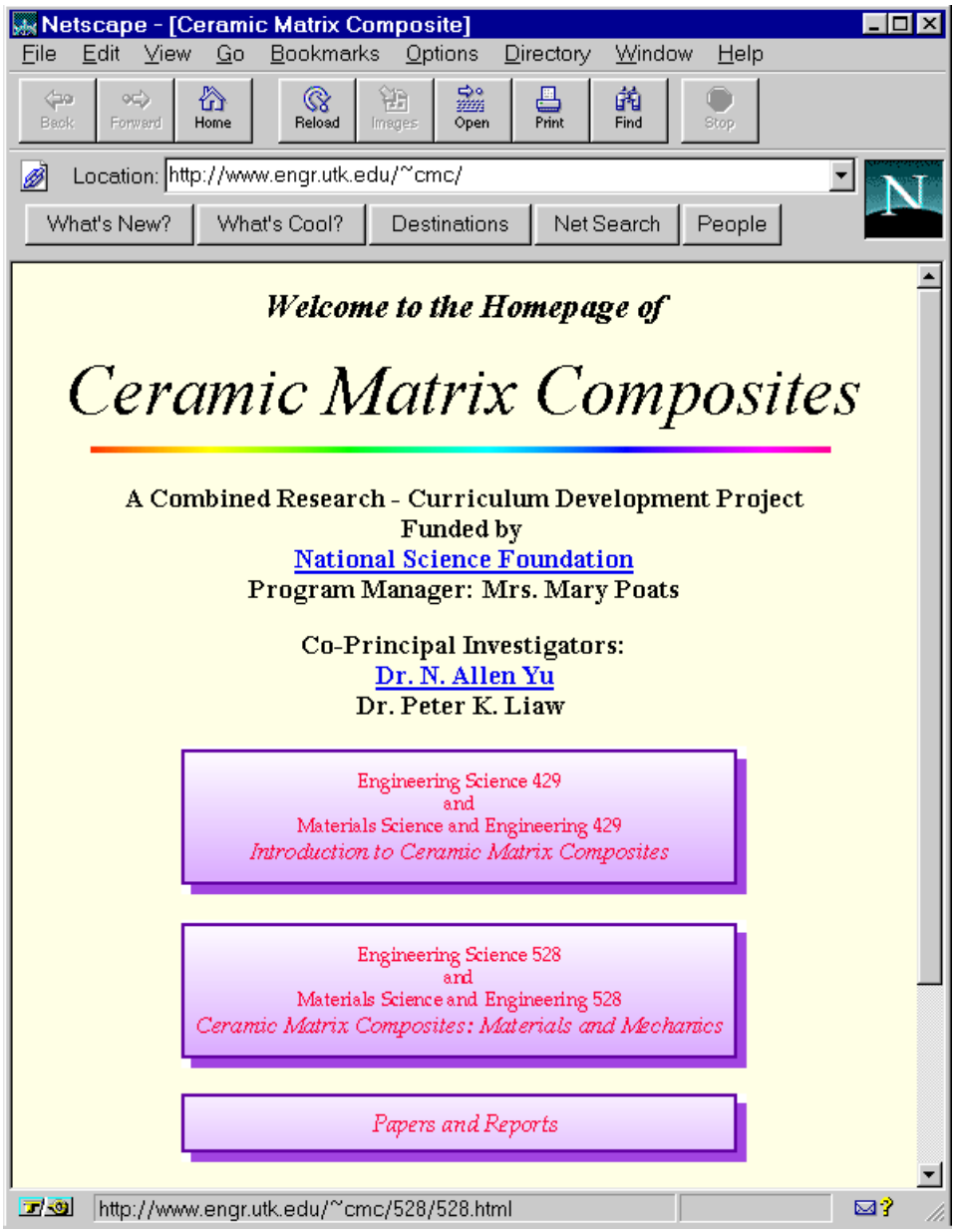

Figure 1. Ceramic-matrix composites: WWW-based courseware

Experimentation of materials processing and characterization have been videotaped for instructional purpose. The videotapes assist the students in their preparation for hands-on projects before going into the laboratory. This also saves both time and money associated with repeated demonstrations and experimentation. The videotapes have been not only edited into several short clips for the inclusion into the WWW-based course but also presented in the classroom.

Moreover, the learning process can be interactive. For example, students may do on-line exercises that can be answered promptly for instantaneous feedback. An integral part of the present courseware is the feedback/evaluation mechanisms. On-line questionnaire including

comments and multiple choice questions have been implemented so that teaching evaluation forms can be filled out anonymously anytime and anywhere a networked computer is available. Instructors and students thus interact with each other in an effective and timely manner.

It is noted that the hypermedia courseware is accessible to all students and professionals having Internet access to WWW and is registered with several top search engines on WWW. The dissemination of the results of the present efforts is apparently widespread.

Other Merits

Interdisciplinary Approach

The development of new engineering materials, such as ceramic-matrix composites, involves several technologically important aspects: materials design, processing, characterization, and simulation/modeling, all of which are inter-related. Proper processing techniques may need to be developed for fabricating materials designed for specific technical needs. Newly developed materials need to be systematically characterized to determine their performance. The mechanics models based on the understanding resulting from materials characterization delineate the interactions between material property and microstructure and hence, provide guidelines for materials design; Figure 2.

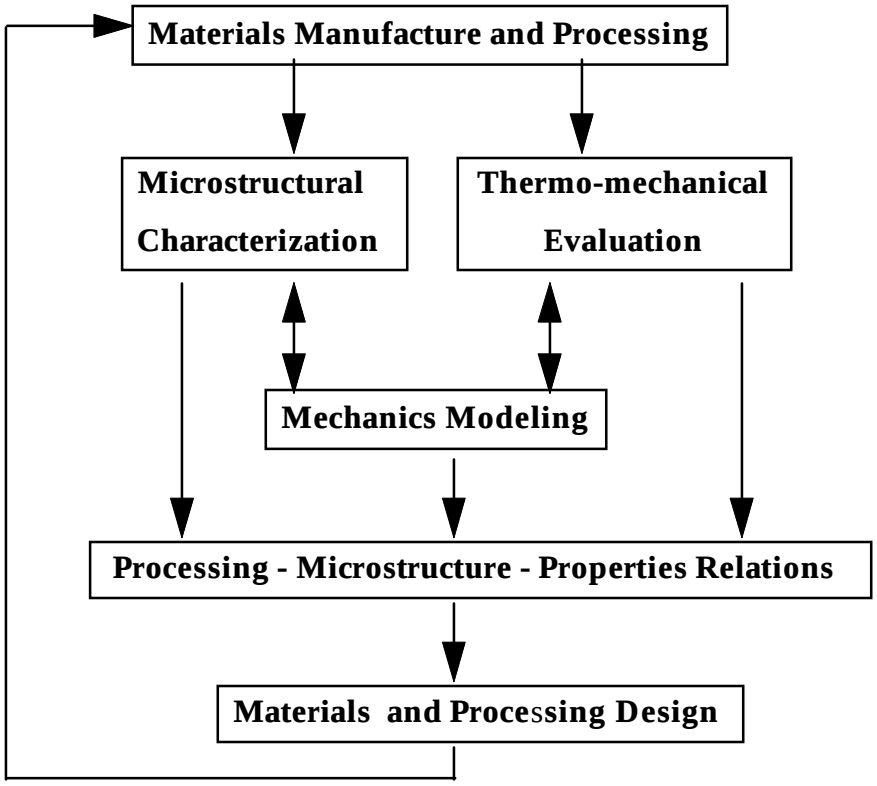

Figure 2. Interdisciplinary approach to the development of advanced materials

Collaboration with National Laboratories

In the present CRCD project, UT collaborates with Oak Ridge National Laboratory (ORNL), one of the leading organizations in the research and development of ceramic-matrix composites. ORNL scientists give lectures, conduct lab demo/tours, help design projects, and evaluate the effectiveness of the present curriculum development. It is noted that the partnership between academia and private industry has been emphasized by various government agencies in

recent years. However, the interaction between academia and national laboratories, most of which have extensive experience in research and development, has not been well addressed. The successful UT-ORNL collaboration provides a national model for university-national laboratory partnership.

Integration of Research into Education

All of the ORNL scientists participating in the present CRCD projects are leading researchers in the various areas of ceramic matrix composites. Each of them gives lectures on topics of their expertise. The two coordinators of the courses (i.e., the two co-principal investigators of the present CRCD project) give lectures connecting these individual topics with one another to ensure that the subject matters are presented in a coordinated, not a fragmented, manner, as depicted in Figure 3.

Distance Education

The present courses are not only offered at UT's Knoxville campus (including the evening school) but also televised through UT Distance Education's network. Therefore, the students and professionals in the evening school, other UT campuses, and all of the institutions that have agreements with UT, are able to enroll in these courses.

Teamwork, Presentation and Communication Skills, and Design Projects

The students enrolling in the present interdisciplinary courses are divided into teams with each team working on a different design project proposed by the participating UT faculty and ORNL scientists. Typical projects include the design of experiments or materials microstructure. To develop communication skills, students provide both written reports and oral presentations periodically during the semester.

Conclusion

The present WWW-based courseware includes on-line hypermedia documents with audio/video effects, computer animation, and interactive modules. The innovative educational delivery developed will stimulate students' interests, add to the dimensions of the instructors' knowledge transfer, enhance the effectiveness of students' learning, and aid in the dissemination of the developed courseware to a very broad audience.

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