3450 Microwave Processors or can be ordered as an accessory. Precise temperature increase and power control during microwave protocols is now available for the first time. Ted Pella, Inc.: (916)243-2200, Fax: (916)243-3761, www.tedpella.com

➡ Orientation Imaging Microscopy (OIM) from **TexSEM Laboratories** (TSL), previously available only on Silicon Graphics and Sun Workstations, is now available on IBM compatible PCs equipped with Windows 95 or Windows NT. Efforts have been focused on making the user interface as easy-to-use as possible, while retaining the power and flexibility of our Unix-based OIM software. EBSP software is now de-coupled from post-processing analytical functions, so that users don't tie up their SEM computer while analyzing data from a previous OIM run. TexSEM Laboratories: (801)344-8990, Fax: (801)344-8997, www.itsneet.com/~tsl

➡ **Topcon Technologies Inc.** exhibited its new affordable integrated SEM/EDS package featuring the Opti-SEM 300LV and the Symphonix EDS system. Topcon's Opti-SEM 300LV model is equipped with a unique built-in optical targeting microscope. Intuitive Windows software for SEM operation and imaging and a fully automated low vacuum system. The Symphonix EDS system includes light element detection, qualitative and quantitative elemental analysis, and analog mapping. This integrated SEM/EDS package offers full analytical capability at an affordable price by merging the SEM and EDS hardware and software into a single stand-alone computer. Topcon Technologies, Inc.: (800)538-6850, Fax: (210)262-1504, www.topcon.com

➡ **TopoMetrix** brought three SPM systems to the conference: the new Accurex II™ for industrial applications, the Observer™ SPM for SEM, and the versatile Explorer™. Accurex II is intended for industrial metrology applications, in which measurement accuracy in all three dimensions is important. It is an integrated system, which can handle a wide range of sample sizes and types, as well as many imaging modes. It utilizes the TrueMetrix™ scanner, which has a patented real-time, closed-loop linearized design. Observer is an SPM designed to work inside an SEM vacuum chamber. The SEM/SPM system combines the strengths of both techniques, allowing roughness and depth measurements to be made without cross sectioning. Explorer is an extremely versatile system, which can provide images using any SPM mode on samples of any size. TopoMetrix: (408)982-9700, Fax: (408)982-9751, www.topometrix.com

➡ **Vision Engineering, Inc.** introduced the new COBRA® stereo microscope with proprietary Expanded Pupil (EP®) technology. EP viewing substantially increases the viewing distance between the eye and eyepiece, allowing freedom of head movement in all three planes of motion. Coupled with superior optics, EP viewing enables the user to comfortably view a high resolution image without the eye, neck, and back fatigue associated with conventional eyepiece microscopes. The COBRA features zoom magnification up to 160X with attractive working distances and a wide range of mounting, lighting, and photomicrography options. Vision Engineering, Inc.: (860)355-3776, Fax: (860)355-0712

➡ **Vital Image Technology** introduced the DKC-5000 Catseye digital camera designed to meet a broad range of requirements in microscopy. This camera can capture images as large as 1520 x 1144 with 10-bit A/D conversion for increased tonal expression and in ISO equivalents of 100, 200, 400 and 800. For low light applications, the Catseye shutter can remain open for 4 seconds. With 30 fps RGB output, users can display in real-time for focus and lighting requirements. The camera has a SCSI-2 interface for image transfer and can store up to 10 images in memory before downloading to a computer. The Catseye is easily connected to all commonly used optical and *stereo microscopes. In addition, this camera is instantly compatible with the most* powerful and preferred image processing software packages available for PC and Macintosh computers. Vital Image Technology: (330)940-3200, Fax: (330)940-3222

➡ **XEI Scientific** displayed its line of Automatic SEM-CLEAN Nitrogen purge systems for Hitachi, JEOL, and other SEMs. These programmable timer controlled auticontamination systems are particularly useful with high-resolution, field emission SEMs or where oil condensation interferes with low energy X-ray detection. XEI Scientific: (650)369-0133, Fax: (650)363-1659/

Apple Launches Educational Object Economy

Jim Spohrer, Advanced Technology Group, Apple Computer

Whether they need Chinese language flash cards, steps and music to a Scottish country dance, physics simulations, or any one of hundreds of other teaching tools, educators and researchers can find them at Apple's Educational Object Economy (EOE) project (http://trp.research.apple.com).

The EOE is a complementary online community based around the creation, sharing, and use of teaching resources that incorporate Java applets for web-based learning. Java applets are small, easy-to-use programs written in Sun Microsystem's Java programming language. Using virtually any computer equipped with a standard web browser, educators can access hundreds of teaching and curriculum development tools for use in the classroom, for research, or in other educational endeavors.

The goal of the project is to build an on-line community who can share a rich pool of information, teaching plans and other related resources. The community will be made up of educators and researchers, as well as users and producers of learning materials (including developers and learners) and distributors of learning materials (businesses).

The project also promotes participation in a "Learning Community", which encourages education in settings and situations beyond the walls of the traditional classroom. The EOE is a learning community which is both concerned with new pedagogies as well as new means of developing and distributing learning materials.

"Apple is taking the lead in creating an open Educational Object Economy and will work with others to build a successful on-line community that shares and adds value to the latest technological advances in web-based teaching and learning tools," said Mike Lorion, Vice President of Apple's Education Division. "This research project will help us understand the way technological and social innovations interact to give rise to thriving on-line learning communities".

The EOE project seeks to make building educational software easier and faster and to establish self-sustaining and self-regulating communities among educators, software developers and businesses.

"The Educational Object Economy encourages educators to share and reuse objects and to build communities that foster collaboration and cooperation in the development and distribution of teaching tools," said Jim Spohrer, co-principal investigator and distinguished scientist in Apple's Learning Communities Group. "We want to help eliminate duplication of effort among educators - a developer working with a math teacher on an Algebra 101 program shouldn't have to build a graphing tool from scratch, especially if an off-the-shelf component from the EOE can be plugged in with little or no modification."

Though still in its early launch stage, the EOE has already attracted the attention of a significant group of educators, developers, researchers, and businesses nationwide.

"The development of an 'object economy' could revolutionize the way software is developed" said Thomas Kalil, White House National Economic Council. "We think that it Is particularly important to create components that will allow faster, cheaper, and easier development of exciting educational software for children. Using technology to change the way teachers teach and students learn is one of President Clinton's top priorities.

Bob Johansen, president of the California-based Institute for the Future, commented, "Web users tell us they need information, telecommunities of contacts, and knowledge creation resources. The Educational Object Economy touches on all three and Is an Important experiment to watch. This is a telecommunity of teachers, developers, and businesses, all in search of ways to appreciate their own intellectual capital."

Educators, software developers, businesses, and other interested parties are encouraged to visit the EOE site to join in the discussions, to contribute work to the directory, and to become a member of the community.

The Apple-led EOE is a project of Apple's Advanced Technology Group and several universities, including Stanford University, the University of Massachusetts at Amherst, the University of Colorado at Boulder, and Carnegie Mellon University, and publishers Houghton Mifflin and PWS, a Thompson Communication company. The project is funded by a National Science Foundation Grant and the Defense Advanced Project Research Agency.

Additional information on the Educational Object Economy project is available at: http://trp.research.apple.ccm. ■

Critical Issues In Ceramic Microstructures

D. R. Clarke
Materials Department, University of California, Santa Barbara,

As the number and variety of ceramic materials have grown so rapidly in the last few decades, ranging from silicon nitride structural ceramics to the perovskite superconductors to the ferroelectric oxides to semiconducting sensors, the number of scientific and technical issues has also grown rapidly. Many of the basic questions relate to the role the microstructures play in determining the observed physical behavior, but increasingly it is not the geometric properties of the microstructure that are of central concern but rather compositional variations and associated electrical characteristics. These require the continued development of microscopy techniques to complement the tremendous advances in microstructural understanding that have already been made possible by microscopy in the past.

Since the role of microscopy is such a broad one, only a few of the most generic problems in microstructure characterization will be described in this article. The topics selected include the characterization of intergranular films in liquid-phase sintered ceramics, the charge distribution at interfaces and the associated space charge, the epitaxial growth of oxides on oxide substrates, and the use of fluorescence imaging to identify phases and non-destructively measure local strains.

Relatively speaking, the characterization of thin (~1 nm) intergranular films in liquid phase sintered ceramics is an old topic. Since the first identification of the presence of such thin films coating the grain boundaries in silicon nitride ceramics in 1974, a wealth of observations in a wide variety of other ceramics has been reported. It is now known that the films are a remnant, generally silica-rich, phase left wetting the grain boundaries after cooling from the sintering process used to densify the ceramic. It is also known from high-resolution electron microscopy that, rather unexpectedly, the thickness of the intergranular film does not vary from one grain boundary to another despite changes in the grain boundary plane and changes in the relative crystallographic misorientation of the grains on either side of the boundary. The reason for this is not known and represents an important challenge to our understanding of the densification of ceramics as well as the origin of grain boundary wetting by a liquid phase. One model proposes that the intergranular film is stabilized by the action of van der Waals forces and is present as a result of a gradient energy contribution to the overall free energy of the grain boundary. On the basis of the predictions of this model a number of critical observations have been proposed including accurate, high spatial resolution measurements of the composition across intergranular films and into their adjoining grains. Such measurements require the use of field-emission STEMs with EELS but without the radiation damage associated with the use of such high power densities. There is a continuing need for a microscopy that reveals, in quantitative detail and high resolution, the charge distribution along a grain boundary or interface as well as in the associated space charge region. The lack of such a microscopy remains a major impediment to a wide range of subjects, including the charge distribution in Schottky barriers, the potential distribution at grain boundaries in varistor ceramics and solar cells, and the charge depletion at free surfaces. Traditionally the principal technique that has provided some of the required data, primarily the location of recombination centers, has been EBIC in the scanning electron (and optical) microscope. Defocus imaging in the TEM has also been used to examine field distributions at low magnifications in simple structures such as p-n junctions. There is, thus, a tremendous opportunity for electron beam holography once the imaging methodologies, the image reconstruction techniques and image contrast theory have been fully developed.

The successful epitaxial growth of defect-free oxides on oxide substrates is an essential pre-requisite for the use of high-Tc superconductors in device applications and the incorporation of ferroelectric memories in devices, to name just two. It can be argued that with continued process development the defect level will fall, just as occurred through largely empirical development in the silicon industry. However, it is important to recognize that microscopy played a key role in the identification of defects introduced during processing helping to define the direction of process development. Undoubtedly it will be again so for the epitaxial oxides but given that the bonding is different, the crystal structures more complex and the importance of charge effects, microscopies of all types will be required in defect identification.

The fact that most ceramics are, in actuality, wide band-gap semiconductors and hence transparent in the visible makes it possible to use optical based microscopies for analysis. One such methodology uses photoluminescence (fluorescence) in an optical microscope to form images of phases and uses piezospectroscopic shifts to determine local strains. Cr3+ fluorescence has proven to be particularly suited to the study of alumina-based ceramics, composites and coatings since the R-line fluorescence is both intense and sharp. On account of its similar size and same valence, Cr3+ is a substitutional solute for A13+ in aluminum oxide. When the d3 outer electrons are excited, by an argon ion laser for instance, to higher energy states they return to the ground state emitting principally R-line fluorescence — a doublet at frequencies of 14448 and 14419 cm-1. Other polymorphs, for instance, Q have similar fluorescence but at different frequencies. It is thus possible to map out the distribution of the polymorphs, and has recently been used to study the kinetics of the Q-a transformation in oxide scales formed on NiAl high temperature alloys. One of the surprising findings was that as distinct from the usual linear kinetics of interface controlled transformations, the kinetics were logarithmic. The R-line fluorescence also is suited to strain measurement. When the host lattice, for example a-alumina, is strained the crystal field at the Cr3+ ions is altered thereby changing the energies of the excited states and hence the frequency of the R-line fluorescence. These changes are relatively small (~ 1 cm-1 per GPa) but by measuring the frequency shift the local strain can be calculated. ■

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