Igor Kosacki

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NANOSCALED OXIDES THIN FILMS FOR ENERGY CONVERSION

University of Missouri-Rolla Ceramic Engineering Seminar Series Speaker
November 20, 2003
McNutt Hall, Room 204
3:30pm

Biography:

Igor Kosacki received his M.Sc. (1978) in experimental physics from University Maria Curie-Sklodowska, Lublin, Poland and his Ph.D. (1983) and Dr.Hab. (1991) degrees in solid state physics from the Institute of Physics, Polish Academy of Sciences. He then worked as Assistant Professor in the Department of Physics, Radom Technical University. In 1992, Igor Kosacki joined the Crystal Physics and Electroceramics Laboratory at Massachusetts Institute of Technology, where he worked with Prof. Harry Tuller. In 1995-2001 he was employed by University of Missuri-Rolla as Research Associate Professor joining Prof. Harlan Anderson research group. He is currently working in Oak Ridge National Laboratory (since 2001), Metals and Ceramics Division. Igor Kosacki served as Post-doctoral Fellow at University Pierre and Marie Curie, Paris (1990) and Delft University of Technology, Holland (1991).

Igor Kosacki was the recipient of a CNRS Award for Visiting Professor, University of Pierre and Marie Curie in Paris (2001) and the Award of the Scientific Secretary of Polish Academy of Sciences for achievements in the research of superionic conductors (1989). He also received the number of Awards of the Rector of Radom Technical University for the achievements in the research and teaching excellence (1983,1984,1986,1987,1988,1989). In 1985 he was recipient of the Award for The Best Young Scientist.

Igor Kosacki's research is aimed at understanding composition, structure-property-performance relationships in ion conducting materials. This involves the processing and the evaluation the electrical and optical properties of single crystals and micro- and nanocrystalline oxygen conductors. His current research emphasizes the defect structure and matter transport mechanism in nanocrystalline oxides. Studies involve the quantum and phonon confinement effects and they correlation with electrical transport and optimization of solid electrolytes for electrochemical devices including fuel cells, gas sensors and ionic membranes. Igor Kosacki has authored more than 100 articles in refereed journals including 5 invited review papers and chapter in the book. He has given numerous of invited lectures at international conferences and has more than 700 citations in the scientific literature.

Abstract:

Intensive studies of ionic conductors have been stimulated by their possible use in fuel cells, gas sensors and batteries. This presentation will discuss the electrical and optical properties of oxygen solid electrolytes and how they may be optimized. The recent results obtained in a study of the influence of microstructure on the electrical and lattice dynamic properties of nanocrystalline acceptor-doped ZrO_2 and CeO_2 thin films will be presented and discussed. These systems are exceptional solid electrolytes for many applications in electrochemical devices. A variety of characterization techniques including x-ray diffraction, electron microscopy, impedance spectroscopy and Raman scattering have been used for the evaluation of nanoscaled materials. The correlation between the measured properties and defect model will be presented. An important feature of the results is the relationship between strain and grain size discovered for nanocrystalline YSZ thin films. The strain becomes significant only when grain size is < 50nm and then increases rapidly with further decrease in grain size. The high strain observed in nanocrystalline films can also stabilize the cubic structure in undoped ZrO_2 thin films. This is remarkable because in bulk ZrO_2 cubic structure is stable only in temperatures above 2300^{o}C.

The results show that properties of nanoscaled oxides can be significantly enhanced. A nanoscale effect that results in exceptionally high ionic conductivity is observed in films with controlled microstructure or thickness below 60nm. These behaviors represent an increased contribution of interface/surface conductivity. This offers the opportunities for developing new oxygen conductors whose properties can be effectively controlled by microstructure or thickness in nanometer scale. The aim of this presentation is to illustrate the way that fundamental research and the understanding of phenomena can lead to development of materials, which have properties that are useful for practical applications.

A meeting of the UMR Chapter of the American Ceramic Society and the Missouri Chapter of Keramos will follow the Seminar in McNutt 211.