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RESEARCH INTERESTS

Mechanical and fracture property evaluation of structural and functional materials; advanced microstructure characterization of metals and ceramics; research and development of energy related materials.

EDUCATION

University of Florida, Gainesville, FL 01/2003-12/2006
Ph.D. in Materials Science and Engineering
Dissertation: *Effect of Reduction Treatment on Microstructure and Mechanical Properties of Fluorite Oxides (advisor: Dr. Fereshteh Ebrahimi)*

University of California, Santa Barbara, CA 08/2006
Summer School on Advanced Thermostructural Materials

University of Science & Technology Beijing, Beijing, P. R. China 09/1999-04/2002
M.S. in Materials Science and Engineering
Thesis: *Microstructure-Mechanical Property Relationship of Micro-alloyed Steels*

University of Science & Technology Beijing, Beijing, P. R. China 09/1995-07/1999
B.S. in Materials Engineering

RESEARCH EXPERIENCES

Postdoctoral associate, Materials Science and Technology Division 09/2007-present
Oak Ridge National Laboratory, Oak Ridge, TN

High strain rate tensile testing

- Dp980/550 steel and AM60, AZ31 magnesium alloys were tested at strain rates up to 1000/s using a custom designed MTS mechanical testing system. The sample deformation was successfully evaluated *in-situ* using a 3D Digital Imaging Correlation technique.

Cathode side interfacial fracture toughness of planar SOFCs

- Interfacial fracture toughness between LSM contact paste and Solid Oxide Fuel Cell (SOFC) interconnects was evaluated as function of sintering conditions using modified bending test method.

Creep and stress relaxation of ferric stainless steels

- Two ferritic stainless steel interconnected materials for Solid Oxide Fuel Cells were compared for their creep and stress relaxation behaviors. It was found that adjustments in the alloy minor constituents could affect both behaviors significantly.

***In-situ* growth stress/residual stress evaluation of oxide scales**

- With *in-situ* Synchrotron X-Ray Diffraction technique, the oxide scale growth stresses were evaluated for SS441 and Crofer at National Synchrotron Light Source (Brookhaven National Laboratory). The residual stresses in the oxide scale were measured at high temperature as a function over oxidation time. The thermal expansion mismatch between the metal substrate and the oxide scale results in large residual stresses at room temperature, which in turn cause delamination of the oxide scales.

Development (Mn, Co) oxide coatings for metallic interconnects

- Combustion synthesis was used to develop (Mn, Co) oxide protective coatings for SS441 and Crofer interconnect. The coatings were applied through screen printing. *In-situ* high temperature residual stresses in the coating were analyzed using synchrotron radiation. Effect of coatings on the high temperature performance was studied.
- Phase evolution of the coating was monitored during reduction and re-oxidation processes using X-Ray Diffraction.

Characterization and development of glass seals for SOFCs

- Crystallization of the glass was characterized using XRD; Thermo-mechanical properties of commercial glass seals for SOFC systems were studied; Wetting behavior Characterization of the glass on SOFC components were evaluated; Aging effect on the glass transition temperature and the interaction between the glass and the components were evaluated; a new engineering seal configuration was proposed for performance improvement.

Elastic properties of thin film coating

- Experimental and analysis techniques were developed for evaluation of elastic modulus of thin film coatings.
- With Resonant Ultrasound Spectroscopy combined with FEM (ANSYS), the elastic moduli of thin LSM coatings on Zirconia were evaluated as function of temperature, film thickness and aging time.

Research Assistant, Department of Materials Science and Engineering 01/2003-08/2007
University of Florida, Gainesville, FL

Effect of reduction treatment on microstructure and mechanical properties of fluorite oxides

- An ordered pseudo-cubic fluorite phase was found in cerium oxide after low oxygen partial pressure reduction treatment; room-temperature phase transformation of the ordered phases was studied. TEM work showed these ordered phases are in nano-sized regime, consistent with the results from XRD. Micro-cracks were found in SEM and its formation mechanism was found due to the internal stresses caused by chemical expansion mismatch.
- Analytical models were derived for the dependence of the elastic modulus on point defect concentration. The prediction was confirmed by the evaluation on the intrinsic elastic modulus using nano-indentation. The deviation of the bulk elastic modulus from the model was found to be related to the microcrack formation.
- Defect concentration effect on hardness was evaluated using nano-indentation. A maximum value was found for the hardness as a function of oxygen partial pressure. The mechanism was proposed to be related to the reduction in the elastic modulus and the increased interaction between point defects and dislocations.
- Fracture strength and fracture toughness as a function of oxygen partial pressure was investigated using MTS810 hydraulic system. The reduction treatment had opposite effects on fracture strength and toughness. Fractographic analysis showed that the enhanced fracture toughness was related to microcrack toughening and deflection toughening and the preexisting microcracks were responsible for the decreased strength. The complex residual stress state was another important factor for the observed results.

Hydrogen embrittlement of austenitic stainless steel

- A sulfuric acid electrolyte solution was used to electro-cathodic charge hydrogen into austenite stainless steel. The effects of hydrogen on tensile and fracture properties were examined. Samples charged with hydrogen showed reduced ductility. The fracture surface of the charged sample showed brittle fractured facets. The hydrogen was removed from the charged samples by baking. The loading-unloading method showed much more recovery of the ductility than the uncharged samples. The results were consistent with the hydrogen enhanced localized plastic deformation mechanism.

Microstructure and mechanical property analysis of other alloys

- Development and Microstructure characterization of Ti-Al-Nb alloys; Study of high temperature deformation mechanism and fractorgraphic analysis of Nickel-base superalloys; Evaluation of tensile properties and analysis on stress-strain curves of shape memory alloy; Evaluation of the heat treatment condition effects on tensile properties of banitic steels.

QUALIFICATIONS AND SKILLS

Proficient in mechanical properties testing, including dynamic measurements, flexural, tensile, compression, indentation and impact tests.

Skilled with advanced characterization techniques, including Digital Imaging Correlation, *in-situ* Synchrotron X-Ray Diffraction, SEM, TEM and FIB.

Familiar with electrochemistry and electrodeposition techniques.

Synergistic Activities:

Member: *American Ceramic Society, ASM International (Oak Ridge Chapter),*
Keramos, Alpha Sigma Mu Honor Society.

Manuscript reviewer: *J. Appl. Ceram. Tech., ACerS Conference Proceedings,*
MRS Symposium Proceedings, J. Urological Research.

HONORS

Coauthor of the IGTI/ASME Ceramic Committee's "Best Paper award" for 2009
Travel scholarship from ICMR to Summer School on Advanced Thermostructural Materials, 2006
Graduate Award for excellence in academic achievements, 2003
1st Place-Best Student Thesis Award, 1999, 2002
Outstanding Peking Graduate/Undergraduate Student Award 1999, 2002
CITIC-CBMM Niobium Contained Steel Scholar and RongDa Scholar, 1998, 2000

LIST OF PUBLICATIONS

- **Y. Wang**, H. Xu, D. L. Erdman, M. Starbuck and S. Simunovic "Characterization of High Strain Rate Mechanical behavior of AZ31 magnesium alloy using 3D Digital Image Correlation", To be submitted
- **Y. Wang,** E. Lara-Curzio, K. L. Moore, L. Walker, R. M. Trejo, T. R. Watkins and J. Bai,, "In-situ synchrotron X-Ray Diffraction studies on the oxide scale of ferritic stainless steel interconnect (AL441) in Solid Oxide Fuel Cells", to be submitted to *Mater. Sci. Eng. A.*
- K. L. More, L. R. Walker, **Y. Wang**, E. Lara-Curzio et.al. "Microstructural and mechanical characterization of hybrid oxide CMC combustror liner after 25,000 hour engine test", *Proceedings of ASME TURBO EXPO 2009*,:GT2009-59223 ***(Best paper award)***
- H. Xu, R. K. Behera, **Y. Wang,** F. Ebrahimi, S. B. Sinnott, E. D. Wachsman, and S. R. Phillpot, "A Critical Assessment of Interatomic Potentials for Ceria with Application to its Elastic Properties" , *Solid State Ionics, Accepted*
- **Y. Wang**, B. L. Armstrong, R. M. Trejo, J. Bai, T. R. Watkins and E. Lara-Curzio, "Mechanical properties of cathode-interconnect interfaces in planar SOFCs", ICACC, Advances in Solid Oxide Fuel Cells V, (2009).
- **Y. Wang**, K. Duncan, E. Wachsman and F. Ebrahimi, "Effects of reduction treatment on fracture properties of cerium oxide", *J. Am. Ceram. Soc.*, 90[12], 3908 (2007).
- **Y. Wang**, K. Duncan, E. Wachsman and F. Ebrahimi, "The effect of oxygen vacancy concentration on the elastic modulus of fluorite-structured oxides", *Solid State Ionics* **178**[1-2], 53 (2007).
- K. Duncan, **Y. Wang**, S. Bishop, F. Ebrahimi, E. Wachsman, "The role of point defects in the physical properties of nonstoichiometric ceria", *J. Appl. Phys.*, **101**[4], 044906 (2007).
- K. Duncan, **Y. Wang**, S. Bishop, F. Ebrahimi and E. Wachsman, "The role of point defects in the physical properties of Fluorite oxides", *J. Am. Ceram. Soc.*, **89**[10], 3162 (2006).
- **Y. Wang**, K. Duncan, E. Wachsman and F. Ebrahimi, "Effects of oxygen vacancy concentration on mechanical properties of cerium oxide", *ECS Trans.*, (Solid State Ionic Devices **IV**, vol. 1) (2005).
- Y. Kang, **Y. Wang**, Y. Zhang, et.al., "Study on deformation resistance of micro-alloyed steels", (in Chinese) *Chin. Mech. Eng.*, **2** (2002).
- **Y. Wang**, J. Sun, Y. Kang, et al., "Deformation effects on the microstructures and mechanical properties of Micro-alloyed steels", (in Chinese) *Proc.2nd Annu. Metal. Conf.*, Beijing, (2000).

BOOK CHAPTERS

Solid Oxide Fuel Cell Design Guide, appendix A (materials property characterization) and sections in chapter 4.2 (materials properties) and chapter 7 (design/failure criteria).

LIST OF PRESENTATIONS

- **Y. Wang**, B. L. Armstrong, R. M. Trejo, J. Bai, T. R. Watkins and E. Lara-Curzio, "Mechanical properties of cathode-interconnect interfaces in planar SOFCs", 2009 American Ceramics Society Cocoa Beach Meeting, Daytona Beach, FL (2009).
- **Y. Wang**, K. Duncan, M. Kesler, E. Wachsman, F. Ebrahimi, "Effect of Heat Treatment in Reducing Atmosphere on Mechanical Properties of Ceria", 2007 American Ceramics Society Cocoa Beach Meeting, Daytona Beach, FL (2007).
- F. Ebrahimi, **Y. Wang**, K. Duncan, E. Wachsman, "The Effect of Oxygen Vacancy on Mechanical Properties of Ceria", 2006 TMS Annual Meeting, Orlando, FL (2006).
- **Y. Wang**, K. Duncan, E. Wachsman, F. Ebrahimi, "The Effect of Oxygen Lattice Vacancies on Mechanical Properties of Fluorite-structured Oxides", (Part of elastic modulus) in 2005 American Ceramics Society Cocoa Beach Meeting, Daytona Beach, FL (2005); (Part of fracture properties) in 2005 Electrochemical Society Meeting, Los Angles, CA (2005).
- **Y. Wang**, K. Duncan, E. Wachsman, F. Ebrahimi, "The Effect of Lattice Vacancies on Mechanical Properties of Cerium Oxide", 2004 Materials Research Society Fall Meeting, Boston, MA (2004).