25th Symposium on Effects of Radiation on Nuclear Materials

Sponsored by ASTM Committee E10 Nuclear Technology and Applications

June 15-17, 2011
Marriott Anaheim
Anaheim, CA

Symposium Chair: Takuya Yamamoto
University of California - Santa Barbara
Santa Barbara, CA

Symposium Co-Chair: Mikhail Sokolov
Oak Ridge National Laboratory
Oak Ridge, TN

Symposium-Co-Chair: Brady Hanson
Battelle Memorial Institute
Richland, WA

8:00 AM - 12:00 PM Workshop on Emerging Trends in Nuclear Energy -
The Standards Component
[Grand Ballroom F]

Objective:
ASTM International will be holding an informative and timely workshop on “Emerging Trends in Nuclear Energy—The Standards Component”. Representatives from the Nuclear Regulatory Commission (NRC) have been invited to present their concepts and views on how nuclear energy is and will continue to be a solid resource for alternative energy and how sound standards will impact its strength, reliability, and perception to the public.

12:00 PM Lunch (On Your Own)
25th Symposium on Effects of Radiation on Nuclear Materials

WEDNESDAY, JUNE 15, 2011

PLENARY

1:00 PM
Opening Remarks
T. Yamamoto, Symposium Chairman

Session I: LWRS (1) ISSUES AND PROGRAMS
[Grand Ballroom F]

Session Co-chairs: Roger E. Stoller, Oak Ridge National Laboratory
Milan Brumovsky, Nuclear Research Institute Rez plc

1:05 PM  Invited
Materials Issues and Research for Extended Reactor Service
J. Busby, Oak Ridge National Laboratory, Oak Ridge, TN, USA

1:30 PM  Invited
Issues Potentially Impacting Long-Term Safe Operations
G. Carpenter, U.S. Nuclear Regulatory Commission, Washington, DC, USA

1:55 PM  Invited
RPV Embrittlement Beyond 60: Issues from Operating Plant Perspective
J. Gaertner and R. Tilley, EPRI, Charlotte, NC, USA; and R. Pathania, EPRI, Palo, Alto, CA, USA

2:20 PM  Invited
Long Term Irradiation Phenomena in RPV Steels - The LONGLIFE Project
E. Altstadt, Forschungszentrum, Dresden-Rossendorf, Germany

2:45 PM  Break

3:05 PM Invited
Needs of Research Activities on Radiation Effects in Nuclear Materials in Japan
N. Soneda, CRIEPI, Koame, Tokyo, Japan

3:30 PM
Panel discussion (questions for all key talks)
Session II: LWRS (2) RPV EMBRITTLEMENT PREDICTION MODELS
[Grand Ballroom F]

Session Chair: Naoki Soneda, CRIEPI

4:40 PM
A Wide-Range Embrittlement Trend Curve for Western RPV Steels
Mark Kirk, USNRC, New Market, MD, USA

5:05 PM
Long Term Irradiation Effects on the Mechanical Properties of Reactor Pressure Vessel Steels
Pål Efsming, Royal Institute of Technology, KTH, Stockholm, Sweden; and J. Rouden, R. Inghals AB, Stockholm, Sweden

5:30 PM
Experimental and Modeling Studies on the Effects of a Wide Range of Flux on the Microstructures and Mechanical Properties of RPV Steels Predicting Low Flux High Fluence Embrittlement
G. R. Odette, T. Yamamoto, N. Cunningham, and D. Klingensmith, University of California, Santa Barbara, Santa Barbara, CA, USA; R. Nanstad, Oak Ridge National Laboratory, Oak Ridge, TN

5:55 PM Symposium Adjourns for the Day

THURSDAY, JUNE 16, 2011

Session III-A: LWRS (3) HIGH FLUENCE AND FLUX EFFECTS [Orange County 1]

Session Co-chairs: G. Robert Odette, University of California Santa Barbara
Randy K. Nanstad, Oak Ridge National Laboratory

8:00 AM
Irradiation Effects at Relatively High Fluence on Five RPV Materials
R. Nanstad, M. Sokolov, Oak Ridge National Laboratory, Oak Ridge, TN, USA; E. Lucon, SCKCEN, Mol, Belgium

8:25 AM
The Influence of Alloy Composition on the Magnitude of the Flux Effect on Irradiation Hardening of RPV Steels
Mark Kirk, USNRC, New Market, MD, USA

8:50 AM
Analyses of IVAR Database for an Advanced MD/CRP Hardening Models
T. Yamamoto, and G. R. Odette, University of California, Santa Barbara, CA, USA
9:15 AM
**Effect of Irradiation Temperature on Hardening and Microstructural Changes of Heavy Ion-Irradiated Reactor Pressure Vessel Steel and Model Alloys**
K. Dohi, K. Nishida, A. Nomoto, N. Soneda, CRIEPI, Tokyo, Japan

9:40 AM Break

10:00 AM
**LTO and Surveillance Specimen Programme of RPV**
Milan Brumovsky and M. Marek, Nuclear Research Institute Rez plc, Czech Republic

10:25 AM
**Fracture Mechanics Characterisation of Decommissioned Reactor Pressure Vessel of NPP Greifswald WWER-440 Unit 4**
H.-W. Viehrig, Mario Houska, Forschungszentrum Dresden-Rossendorf, Germany; M. Valo, VTT Technical Research Center of Finland, VTT, Finland

10:50 AM
**Atom Probe Characterization of Solute Atom Clustering in the Reactor Pressure Vessel Materials Cut from Decommissioned Greifswald Unit 4**

11:15 AM
**Surveillance Results for the High-Flux Isotope Reactor Pressure Vessel**
R. Nanstad, M. Sokolov, and I. Remec, Oak Ridge National Laboratory, Oak Ridge, TN, USA; R. Cheverton, Consultant, Knoxville, TN, USA

11:40 AM **Lunch (On Your Own)**

**Session III-B: HIGH PERFORMANCE FUEL AND FUEL CYCLE, MATERIALS FOR NUCLEAR APPLICATIONS**
[Orange County 2]

**Session Co-chairs:** Stuart Maloy, Los Alamos National Laboratory
Paul Schuck, Oak Ridge National Laboratory

**High Performance Fuel and Fuel Cycle**

8:25 AM
**IAEA Activities in the Areas of Fuel Performance Analysis and Advanced Radiation-Resistant Materials Development**
V. Inozemtsev, J. Killeen, and A. Zeman, IAEA, Vienna, Austria
8:50 AM
**Degradation of Fuel Cycle Extraction Ligands by Nitrate Radical Reactions: Nitrate Radical Kinetics and Mechanisms in the Aqueous and Organic Phases**
S. Mezyk and T. Cullen, California State University at Long Beach, Long Beach, CA, USA; G. Elias, B. Mincher, Idaho National Laboratory, Idaho Falls, ID, USA

9:15 AM
**Expanding Plug Test of High Burnup HBR Zr-4 Cladding**
Y. Yan, Rick Batiste, C. Baldwin, and B. Bevard, Oak Ridge National Laboratory, Oak Ridge, TN, USA

9:40 AM Break

**Materials for Nuclear Applications**

10:00 AM
**Materials Properties of Irradiated Cladding and Duct Reactor Materials**
T. Saleh, S. Maloy, and T. Romero, Los Alamos National Laboratory, Los Alamos, NM, USA; M. Toloczko, Pacific Northwest National Laboratory, Richland, WA, USA; T. Byun, Oak Ridge National Laboratory, Oak Ridge, TN, USA

10:25 AM
**Characterization of the Nanofeatures in Nanostructured Ferritic Alloys**
N. Cunningham, Y. Wu, G. R. Odette, E. Stergar, and E. Haney, University of California, Santa Barbara, Santa Barbara, CA, USA

10:50 AM
**(U)HMW-PE Study of Structural Differences Induced by Exposure to Gamma Radiation**
D. Wolff, K von der Ehe, M. Jaunich, M. Bohning, and H. Goering BAM Federal Institute, Berlin, Germany

11:15 AM
**Material Investigations on Highly Irradiated Aluminum Magnesium Alloys for Life Time Assessment of a Neutron Beam Tube in the BER II Research Reactor**
H. Hein, AREVA NP GmbH, Erlangen, Germany; S. Welzel, Helmholtz Zentrum Berlin, Berlin, Germany

11:40 PM **Lunch (On Your Own)**
Session IV: HE, H, DPA SYNERGISM (1) - EXPERIMENTAL TECHNIQUES [Orange County 1]

Session chair: F. A. Garner, Radiation Effects Consulting

1:15 PM Invited
In Situ Helium Implantation Studies in HFIR on the Effects of Helium on Cavity and Microstructural Evolution in Tempered Martensitic Steels and Nanostructured Ferritic Alloys
G. R. Odette, T. Yamamoto, University of California, Santa Barbara, Santa Barbara, California, USA

1:50 PM Invited
Use of Mev Ion Beams to Simulate the Irradiation Effects in Advanced Materials at JANNUS Saclay
P. Trocellier, Commissariat l'Energie Atomique, Gif-Sur-Yvette, France

2:25 PM
Modeling and TEM Investigation of Helium Bubble Growth in RAFM Steels under Neutron Irradiation
E. Gaganidze, C. Dethloff, J. Aktaa, and O. Weiss, Karlsruhe Institute of Technology, Eggenstein-Leopoldshafen, Germany; V. Svetukhin, M. Tikhonchev, Ulyanovsk State University, Ulyanovsk, Russian Federation

2:50 PM Break

Session V-A: HE, H, DPA SYNERGISM (2) - MULTIPLE BEAM IRRADIATION [Orange County 1]

Session Co-chairs: Ermile Gaganidze, Karlsruhe Institute of Technology
Enrico Lucon, National Institute of Standards and Technology

3:05 PM
The Material Irradiation Facility of TECHNOFUSiN Centre: a Relevant Key for Fusion Technologies
A. Ibarra Laboratorio Nacional de Fusi—n por Confinamiento MagnŽtico

3:30 PM
Approach of He/dpa Synergistic Effects using JANNUS
P. Trocellier, Commissariat l'Energie Atomique, Gif-Sur-Yvette, France

3:55 PM
Cavity Formation in Multi-Ion-Beam Irradiated ODS Steel
L. Hsiung, M. Fluss, S. Tumey, and W. Choi, Lawrence Livermore National Laboratory, Livermore, CA, USA; F. Willame and Y. Sruuys, CEA, Gif-sur-Yvette, France; and A. Kimura, Kyoto University, Kyoto, Japan
4:20 PM  
**Crystalline Coherency of Oxide/Matrix Interfaces and Bubble Formation Behavior in ODS Ferritic Steel MA956**  
C. Zhang, J. Jang, Y. Yang, Institute of Modern Physics, Lanzhou, P. R. China; H. Cho, Korea Atomic Energy Research Institute, Daejeon, Korea (South); A. Kimura, Kyoto University, Kyoto, Japan

4:45 PM  
**The Role of Helium and Hydrogen Co-Injection on Ion-Induced Swelling of Austenitic 18Cr10NiTi Stainless Steel**  
O. Borodin, and V. Voyevodin, Kharkov Institute of Physics and Technology, Kharkov, Ukraine; F. Garner, Radiation Effects Consulting, Richland, WA, USA

5:10 PM  
**Influence of Helium and Hydrogen on Ion-Induced Swelling of Ferritic-Martensitic Alloy EP-450 to 200 Dpa**  
V. Voyevodin, V. Bryk, Kharkov Institute of Physics and Technology, Kharkov, Ukraine; F. Garner, Radiation Effects Consulting, Richland, WA, USA

5:35 PM  
**Dose and Implantation Rate Effects on Microstructure Evolution in Comparison of In-situ Implanter versus Dual Ion Irradiation Experimental Studies and Model Predictions**  
T. Yamamoto, G. R. Odette, W. Yuan, University of California, Santa Barbara, California, USA; K. Yabuuchi, A. Kimura, Kyoto University, Kyoto, Japan

6:30 PM - 8:30 PM  
**Reception/Banquet [Marquis Northwest]**

---

**Session V-B: MODELING OF RADIATION EFFECTS (1) [Orange County 2]**

**Session Co-chairs:**  
Yury Osetskiy, Oak Ridge National Laboratory  
Maxim Gussev, Oak Ridge National Laboratory

3:05 PM  
**Atomistic Investigations of Intrinsic and Extrinsic Point Defects in Uranium**  
B. Beeler and C. Deo, Georgia Institute of Technology, Atlanta, GA, USA; M. Baskes, Los Alamos National Laboratory, Los Alamos, CA, USA; Rashkeev and M. Okuniewski, Idaho National Laboratory, Idaho Falls, ID, USA

3:30 PM  
**TRISO Fuels: Ab Initio Study of the Reaction of Palladium on the Surface of Silicon Carbide**  
P. Schuck and R. Stoller, Oak Ridge National Laboratory, Oak Ridge, TN, USA

3:55 PM  
**Study of Thermal Transport Properties of Sic**  
G. Samolyuk, S. Golubov, R. Stoller, Oak Ridge National Laboratory, Oak Ridge, TN, USA
4:20 PM
**Thermomechanical Damage of Tungsten under Transient Plasma Heat Loads**
T. Crosby and N. Ghoniem, University of California at Los Angeles, Loa Angeles, CA, USA

4:45 PM
**Crystal Plasticity Simulation Considering Crystal Defect Induced by Irradiation**
Y. Aoyagi, T. Tsuru, Y. Kaji, Japan Atomic Energy Agency, Ibaraki, Japan

5:10 PM
**Preliminary Models on Irradiation Induced Changes of Microstructure and Stress-Strain Relations to Estimate Mechanical Response of Austenitic and Martensitic Steel Components**
S. Jitsukawa, Y. Abe, K. Suzuki, and N. Okubo, Japan Atomic Energy Agency, Ibaraki, Japan

6:30 PM -8:30 PM **Banquet/Reception [Marquis Northwest]**

FRIDAY, JUNE 17, 2011

Session VI-A: **RADIATION EFFECTS IN AUSTENITIC STAINLESS STEELS, MODELING OF RADIATION EFFECTS (2)**
[Orange County 1]

Session Co-chairs: Stanislav Golubov, Oak Ridge National Laboratory
Shiro Jitsukawa, Japan Atomic Energy Agency

**Radiation Effects in Austenitic Stainless Steels**

8:00 AM
**Second-Order Radiation Phenomena Growing to First Order Importance for Austenitic Internals at Higher Damage Levels Associated with PWR Plant Life Extension**
F. Garner, Radiation Effects Consulting, Richland, WA, USA; L. Greenwood, Pacific Northwest National Laboratory, Richland, WA, USA; O. Maksimkin, Institute of Nuclear Physics, Almaty, Kazakhstan; and M. Gussev, Oak Ridge National Laboratory, Oak Ridge, TN, USA

8:25 AM
**Prediction of Void Swelling in the 18crmni10ti Stainless Steel Baffle Ring of VVER-1000 Using Ion and Neutron Data**
F. Garner, Radiation Effects Consulting, Richland, WA, USA; A. S. Kalchenko, V. V. Bryk, N. P. Lazarev, V. N. Voyevodin, Kharkov Institute of Physics and Technology, Kharkov, Ukraine
8:50 AM
Martensitic Transformation during Deformation of AISI304, AISI316, 12Cr18Ni10Ti and 08Cr16Ni11Mo3 Stainless Steels Irradiated by Thermal and Fast Neutrons
M. Gussev, University of Tennessee, Oak Ridge, TN, USA; J. Busby, Oak Ridge National Laboratory, Oak Ridge, TN, USA; F. Garner, Radiation Effect Consulting, Richland, WA, USA; and S. Ruban, M. Merezgko, O. Maksimkin, and S. Ryban, Institute of Nuclear Physics, Almaty Kazakhstan

9:15 AM
In-situ Ion Irradiation Techniques for Nuclear Materials
K. Hattar, E. Bielejec, B Clark, G. Vizkelethy, J. Branson, B. Doyle, Sandia National Laboratories, Albuquerque, NM, USA

9:40 AM Break

Modeling of Radiation Effects (2)
10:00 AM
Dislocation Bias Revisited
S. Golubov and R. Stoller Oak Ridge National Laboratory, Oak Ridge, TN, USA; A. Barashev, The University of Liverpool, Liverpool, United Kingdom; B. Singh, RISO National Laboratory, Roskilde, Denmark

10:25 AM
Computational Modeling of Dislocation Bias for Self-Interstitials
D. Seif and N. Ghoniem, University of California Los Angeles, Los Angeles, CA, USA

10:50 AM
Kinetic Monte Carlo Simulation of Defect Evolution Produced by Primary Damage in BCC Iron
H. Xu, Y. Osetsky, and R. Stoller, Oak Ridge National Laboratory, Oak Ridge, TN, USA; A. Barashev, University of Liverpool, Liverpool, United Kingdom

11:15 AM
Microstructural Evolution of Austenitic Stainless Steel under Cascade Damage Condition Predicted by Cluster Dynamics Simulation: Comparison with Neutron Irradiated Alpha-Iron
Y. Abe, S. Jitsukawa, N. Okubo, and T. Tsukada, Japan Atomic Energy Agency, Ibarakai, Japan; H. Matsui, Kyoto University, Kyoto, Japan

11:40 AM
Atomic-Scale Modelling of Dislocation-Obstacle Interactions in Irradiated Metals
Y. Osetsky and R. Stoller, Oak Ridge National Laboratory, Oak Ridge, TN, USA; D. Bacon, University of Liverpool, Liverpool, UK

12:05 PM Lunch (On Your Own)
Lwrs (3) Microstructure and Mechanical Properties in RPV Steels

8:00 AM
Behavior of Copper and Nickel Atoms in Neutron-Irradiated Model Alloys of Reactor Pressure Vessel Materials
N. Soneda, K. Nishida, A. Nomoto, K. Dohi, CRIEPI, Tokyo, Japan

8:25 AM
Microstructure Response of VVER-440 Reactor Pressure Vessel Steel after Irradiation and Annealing Treatment
A. Zeman, International Atomic Energy Agency, Vienna, Austria; L. Debarberis, European Commission, Petten, Netherlands; V. Grafitin and S. Gogozkin, Institute for Theoretical and Experimental Physics, Moscow, Russia; D. Erak, Kurchatov Institute, Moscow, Russia

8:50 AM
Radiation Damage in Fe-C-Met Model Alloys
M. Brumovsky and J. Kocik, Nuclear Research Institute Rez plc, Czech Republic

9:15 AM
Measurement of Hardness Distribution in Reactor Pressure Vessel Materials by Means of Nanoindentation
A. Nomoto, K. Nishida, K. Dohi, N. Soneda, CRIEPI, Tokyo, Japan

9:40 AM Break

Ni Alloys and Martensitic Steels

10:00 AM
Embrittlement of Nickel Alloys in a CANDU Reactor Environment

10:25 AM
Enhancement of Irradiation Creep of Nickel-Bearing Alloys in Thermalized Neutron Spectra Characteristic of LWR and CANDU Reactors
F. Garner, Radiation Effects Consulting, Richland, WA, USA; L. Greenwood, Pacific Northwest
10:50 AM
**Fatigue and Fatigue-Creep Interaction Behaviour in Irradiated and Unirradiated Eurofer97 Steel**
N. Luzginova, H. Hegeman, P. Pierick, D. Blagoeva, Nuclear Research and Consultancy Group, Petten, Netherlands

11:15 AM
**Dynamic strain aging during deformation of 12Cr18Ni10Ti steel, Armco-iron and low-carbon steel irradiated by either neutrons or alpha-particles**

11:40 AM Lunch (On Your Own)

Session VII: MODELING OF RADIATION EFFECTS (3)
[Orange County 1]

**Session Co-chairs:** Yosuke Abe, Japan Atomic Energy Agency
Takuya Yamamoto, University of California Santa Barbara

1:15 PM
**A Different Method to Develop a Pair Potential for Fe-He**
P. H. Chen, China Academy of Engineering Physics, Mianyang, China

1:40 PM
**The Thermodynamics of Hydrogen-Helium-Vacancy Clusters in BCC Iron**
E. Hayward and C. Deo, Georgia Institute of Technology, Atlanta, GA, USA

2:05 PM
**Atomistic Study of Equilibrium Helium Bubbles in Iron**
D. Stewart, Y. Ostesky, R. Stoller, Oak Ridge National Laboratory, Oak Ridge, TN, USA

2:30 PM
**Ballistic Resolutioning of He from Bubbles in Iron**
R. Stoller, and D. Stewart, Oak Ridge National Laboratory, Oak Ridge, TN, USA

2:55 PM
**Closing Remarks**
Takuya Yamamoto, Symposium Chairman

3:00 PM **SYMPOSIUM ADJOURNS**