12TH INTERNATIONAL SYMPOSIUM ON BEARING STEELS: PROGRESS IN BEARING STEEL METALLURGICAL TESTING AND QUALITY ASSURANCE

Sponsored by ASTM Committee A01 on Steel, Stainless Steel and Related Alloys

May 15-17, 2019
Sheraton Denver Downtown Hotel
Denver, CO, USA

Symposium Chairman: John M. Beswick
Montfoort
The Netherlands

Subcommittee A01.28 Chairman: Jeff Fuller
Amsted Rail
Petersburg, Virginia, USA

ABOUT THE SYMPOSIUM
The objective of the symposium is to bring together rolling bearing steel practitioners to present the latest developments in rolling bearing steels and testing. Papers from steelmakers, semi-finished and finished bearing steel component producers, rolling bearing producers, rolling bearing users and development institutes will be encouraged.

ACKNOWLEDGEMENTS
The organizing committee for the ASTM 12th International Symposium on Bearing Steels: Progress in Bearing Steel Metallurgical Testing and Quality Assurance acknowledges the contributions of the following sponsors:

Jiangyin Xingcheng Special Steel Works Co, Ltd. China
Amsted Rail Co., Inc USA
Ascometal France
Boehler Edelstahl GmbH Austria
Carpenter Technology Corporation USA
Charter Steel USA
FNSsteel B.V. The Netherlands
Georgsmarienhutte GmbH Germany
Gerdau Special Steel North America USA
Ovako AB Sweden
Saarstahl AG Germany
Sanyo Special Steel Japan
SKF B.V. The Netherlands
Timken USA
TimkenSteel USA
TUESDAY, MAY 14, 2019

5:00 PM  WELCOME RECEPTION
(Sheraton Denver Downtown Hotel - Plaza Ballroom C)

WEDNESDAY, MAY 15, 2019

8:00 AM  Opening Remarks, Award Presentation and Symposium Introduction
John Beswick, Symposium Chairman, and Jeff Fuller, A01.28 Chairman

SESSION 1: ROLLING BEARING FAILURE MODES AND ADVANCED ANALYSIS

Session Chair: John M. Beswick, Montfoort, The Netherlands

8:30 AM  Influence of Steel Cleanliness on Rolling Contact Fatigue and White Etching Crack Formation
T. Blass, K. Wunder and W. Trojahn; Schaeffler Technologies AG & Co. KG, Schweinfurt, Bavaria, Germany, X. Xu, K. Geng and F. Li, Jiangyin Xingcheng Special Steel Works. Co. Ltd, Jiangyin City, Jiangsu Province, China

9:00 AM  Rolling Contact Fatigue Transformations in Aero Steels: The Effect of Temperature on Microstructural Decay
X. Liang and P.E.J. Rivera-Diaz-del Castillo, Lancaster University, Lancaster, United Kingdom

9:30 AM  Review on Crack Initiation and Premature Failures in Bearing Applications
E. Vegter, SKF, Nieuwegein, The Netherlands

10:00 AM  BREAK
SESSION 2: MICRO CLEANLINESS RELATIONSHIPS AND TESTING OF AIR-MELT BEARING STEELS

Session Chair: Jeff Fuller, Amsted Rail, Petersburg, Virginia, USA

10:30 AM
Effect of Oxide Inclusion Population on Bending Fatigue Performance in Quench and Tempered Steels
P. Glaws and B. Yoak, TimkenSteel, Canton, Ohio, USA

11:00 AM
Quantitative Ultrasonic Characterization of Subsurface Inclusions in Tapered Roller Bearings
J.A. Turner, S. Deshpande, S. Islam, L.D.Sotelo, M. Norouzian, University of Nebraska-Lincoln, Lincoln, Nebraska, USA; and M. Lumpkin, L.F. Diefenderfer and A.J. Fuller, Amsted Rail, Petersburg, Virginia, USA

11:30 AM LUNCH (on your own)

SESSION 3: DEVELOPMENTS IN RCF TESTING OF BEARING STEELS

Session Chair: Jeff Fuller, Amsted Rail, Petersburg, Virginia, USA

1:00 PM
Investigation of Fatigue Behavior Around Non-metallic Inclusion by Using Newly Developed Rolling Contact Fatigue Test Method
T. Fujimatsu and F. Maezawa, Sanyo Special Steel Co., Ltd., Himeji, Hyogo, Japan

1:30 PM
Design and Validation of a Modular RCF/RSCF Testing Machine
N. Novack, R.L. Cryderman, and T.A. Rimroth, Colorado School of Mines Advanced Steel Processing and Products Research Center, Golden, Colorado, USA
SESSION 4: ROLLING BEARING SURFACE DAMAGE AND EFFECT ON RCF LIFE

Session Chair:         Jim Carosiello, TimkenSteel, Canton, Ohio, USA

2:00 PM
Lubricant Induced White Etching Cracks: Mechanism and Effect of Surface Finish
M. Paladugu, Timken, Canton, Ohio, USA

2:30 PM
Surface Damage in Rolling Bearings and the Impact on Rolling Contact Fatigue
Herzogenaurach, Germany

3:00 PM   BREAK

3:30 PM
Effect of MnS on the Micropitting Behavior of Through Hardened Bearing steel
During Rolling Contact Fatigue
V. Bedekar, C. Hager Jr. and R.S. Hyde, Timken, Canton, Ohio, USA

4:00 PM
Influence of Material, Heat Treatment and Microstructure in Resisting White Etching
Crack Damage
M. Paladugu, R.S. Hyde, Timken, Canton, Ohio, USA

SESSION 5: DIMENSIONAL STABILITY

Session Chair:         Jim Carosiello, TimkenSteel, Canton OH, USA

4:30 PM
Influence of Heat Treatment Conditions on Dimensional Stability of SAE 52100
C. Sidoroff, V. Lejay, P. Dierickx, NTN-SNR Roulements, Annecy, France; C. Le Bourlot, C.
Dessolin and M. Perez, INSA de Lyon, Villeurbanne, France

5:00 PM
Complexity of Dimensional Stability of Case- Hardened Bearing Components
P. Yan and M. Y. Sherif, SKF, Nieuwegein, The Netherlands

6:00 PM   RECEPTION - Hosted by Jiangyin XingCheng Special Steel Company Ltd.
(Sheraton Denver Downtown Hotel – Plaza Ballroom A)
THURSDAY, MAY 16, 2019

SESSION 6 DEVELOPMENTS IN BEARING COMPONENT MANUFACTURING

Session Chair: Aidan Kerrigan, SKF Nieuwegein, The Netherlands

8:00 AM
Selective Laser Melting (SLM) of M50NiL – Enabling Increased Degrees of Freedom in New Design Concepts
P. Mirring, FAG Aerospace GmbH & Co., Schweinfurt, Germany; and C. Merklein and A. Rottmann, Schaeffler Technologies AG & Co., Herzogenaurach, Germany

8:30 AM
Manufacturing of Large-Diameter Rolling Element Bearings by Steel-steel Multi Material Systems
T. Coors, F. Pape and G. Poll, Insitute for Machine Design and Tribology (IMKT), Leibniz University, Hannover, Germany; and M. Mildebrath and T. Hassel, Institute for Material Science (IW), Leibniz University, Garbsen, Germany.

9:00 AM
Ultrasonic Evaluation of Tailored Forming Bearing Components
F. Pape, T. Coors and G. Poll, Institute of Machine Design and Tribology (IMKT), Leibniz University, Hannover, Germany; A. Chugreev, T. Matthias, J. Uhe, and B. Behrens, Institute of Forming Technology and Machines (IFUM), Leibniz University, Garbsen, Germany; and S.E. Thürer and C. Klose, Institute for Material Science (IW), Leibniz University, Garbsen, Germany

9:30 AM BREAK

SESSION 7: DEVELOPMENTS IN AIR-MELT CLEAN BEARING STEEL STEELMAKING

Session Chair: Aidan Kerrigan, SKF Nieuwegein, The Netherlands

10:00 AM
The Use of SEM-EDS and OES-PDA Techniques to Help the Development of the Production of Bearing Steel
A. Spadaccini Acciaierie Bertoli Safau, Udine, Italy; and A. Col, D. Acevedo, C. Stocky ABS Centre Métallurgique, Metz, France

10:30 AM
Improved Processing Techniques for Inclusion-Free Steel for Bearing and Mechanical Component Applications
C. DellaCorte, NASA, Glenn Research Center, Cleveland, Ohio, USA
11:00 AM
**Advances in Steel Cleanliness for High Performance Applications at Gerdau Special Steel North America**
E. Scheid and D. Correa de Oliveira, Gerdau Special Steel North America, Jackson, Michigan, USA

11:30 AM
**Quality Improvements on High Carbon Bearings Steel Based on the Fatigue Testing**
X. Xiaohong, L. Jigang, G. Ke, L. Feng and C. Ru, Jiangyin Xingcheng Special Steel Works., Co. ltd., Jiangyin, China; and H. Munther, LaoHan AB, Hofors, Sweden

12:00 PM
**Performance and Reliability of Powder Metallurgy Steels for Aerospace Bearings**
J. Bellus and A Benbahmed, Aubert & Duval – ERAMET, Les Ancizes, France; J. André and S. Sundin, Erasteel Kloster AB, Söderfors, Sweden; and C. Sidoroff and O. Blanchin, NTN-SNR Rulements, Annecy, France

12:30 PM
**Calcium Enriched Inclusions in Non-Calcium Treated Bearing Steels**
T. Kaczorowski, Charter Steel, Cleveland, Ohio, USA

1:00 PM   LUNCH (on your own)

---

**SESSION 8: NEW AND NOVEL STEEL COMPOSITIONS USAGE IN ADVANCED ROLLING BEARINGS**

Session Chair: Eduardo Scheid, Gerdau Special Steel North America

2:30 PM
**Utilization of Known Quench and Temper Steel Alloys for Demanding Applications**
K.P. Keller, Vestas Nacelles Deutschland GmbH, Lubeck, Germany; and M. Burtchen and B. Lüneburg, ThyssenKrupp Rothe Erde, Dortmund, Germany

3:00 PM
**Hybrid Steel and its Potential for Bearing Applications**
J. Andersson, Ovako Sweden AB, Hofors, Sweden

3:30 PM   BREAK
4.00 PM  
**Temperature Resistant, Corrosion Tolerant Carburising Bearing Steel for Aero-engine Applications**  
A. Kerrigan, M. Sherif, SKF RDC, Nieuwegein, The Netherlands; and A. Mondelin, J. Coudert, and Y. Maheo, SKF Aerospace, Valence, France

4:30 PM  
**High Performance Ferrium® Steels for Aerospace Gearing and Bearing Applications**  
K. Taskin, QuesTek Innovations LLC

---

**SESSION 9: APPLICATION OF FRACTURE MECHANICS TO BEARING STEEL PROPERTY CHARACTERIZATION**

Session Chair: Eduardo Scheid, Gerdau Special Steel North America

5:00 PM  
**Effect of Carbide Segregation on Mode I Fatigue Resistance Properties of the Bearing Tool Steel RBD (Roll Blade Die)**  
A. Molokanov, M. Rawson, T. Moreton, Rolls-Royce Aerospace, UK and G. West, WMG, University of Warwick, Coventry, UK

5:30 PM  
**Relevance of Fracture Mechanics in Rolling Bearing Functional Property Determination and Steel Quality Assurance**  
J. Coudert, A. Mondelin, SKF Aerospace, Valence, France; and A. Kerrigan SKF RTD, Nieuwegein, The Netherlands

6:00 PM  
**RECEPTION**  
(Sheraton Denver Downtown Hotel – Plaza Ballroom A)

---

**FRIDAY, MAY 19, 2019**

**SESSION 10: VIM-VAR STEEL KNOW-HOW - AERO STEELS METALLURGY AND FUNCTIONAL PROPERTIES**

Session Chair: John M. Beswick, Montfoort, The Netherlands

8:00 AM  
**Review Paper: VIM-VAR Steelmaking for Bearing Steel Grades**  
S. Carey, Liberty Specialty Steels, Stocksbridge, Sheffield, S36 2JA, UK

8:30 AM  
**Melt Methods and their Effects on Cleanliness for Bearing Performance**  
G. Shannon and C. Tomasello, Carpenter Technology Corporation, Latrobe, Pennsylvania, USA
9:00 AM
Investing the Initial Stages of Corrosion Propagation on Carburized Pyrowear 675 via in-situ Atomic Force Microscopy
A. Kvryan, K. Higginbotham, P.H. Davis, E. Graugnard, H. Trivedi, and M. F. Hurley, Boise State University, Boise, Idaho, USA

9:30 AM
Spall Propagation Characteristics of Life Tested VIM-VAR M50 and Pyrowear 675 Bearing Steels
H.K. Trivedi, D. Haywood, UES Inc. Dayton, Ohio, USA; and M. Kirsch and L. Rosado, Air Force Research Laboratory, Wright Patterson AFB, Ohio, USA

10:00 AM BREAK

10:30 AM
Spall Propagation Characteristics of as Manufactured Aerospace Bearing Steels Hitesh K
H.K. Trivedi, D. Haywood, UES Inc. Dayton, Ohio, USA; and M. Kirsch and L. Rosado, Air Force Research Laboratory, Wright Patterson AFB, Ohio, USA

11:00 AM
Testing to Reveal Tribology Mechanisms for Advancing Bearing Steels

11:30 AM
Adhesive Wear Performance of Pyrowear 675 in All Metal and Hybrid Configuration
D. Isaac and H.K. Trivedi, UES Inc., Dayton, Ohio, USA; and M. Kirsch, P. Hellmana and A. Foyea, Air Force Research Laboratory, Wright Patterson Air Force Base, Dayton, Ohio, USA

12:00 PM
Accelerated Life Testing of Pyrowear 675 Material on Ball-on-rod Rolling Contact Fatigue Tester at 218 °C (425 °F)
H. Trivedi, UES Inc. Dayton, Ohio, USA; and L. Rosado, Air Force Research Laboratory, Wright Patterson AFB, Ohio, USA

12:30 PM
ASTM A01.28 Committee Information:
Jeff Fuller

12:45 PM
Closing Remarks
John M. Beswick

1:00 PM SYMPOSIUM ADJOURNS