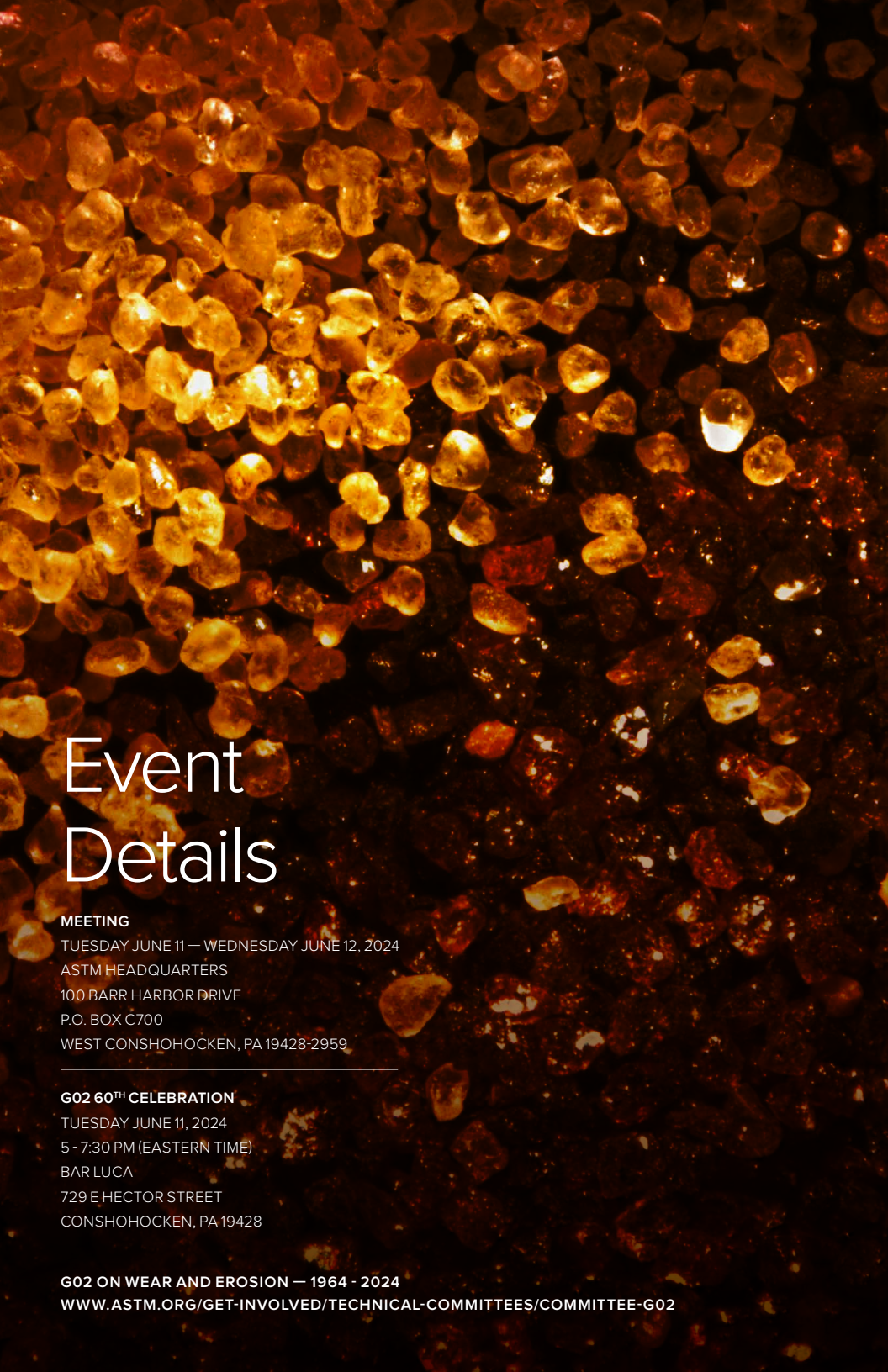
ASTM INTERNATIONAL
Helping our world work better

COMMITTEE GO2 ON WEAR AND EROSION

60th Anniversary Celebration

June 11-12, 2024
West Conshohocken, PA



Event Details

MEETING
TUESDAY JUNE 11 — WEDNESDAY JUNE 12, 2024
ASTM HEADQUARTERS
100 BARR HARBOR DRIVE
P.O. BOX C700
WEST CONSHOHOCKEN, PA 19428-2959

G02 60TH CELEBRATION
TUESDAY JUNE 11, 2024
5 - 7:30 PM (EASTERN TIME)
BAR LUCA
729 E HECTOR STREET
CONSHOHOCKEN, PA 19428

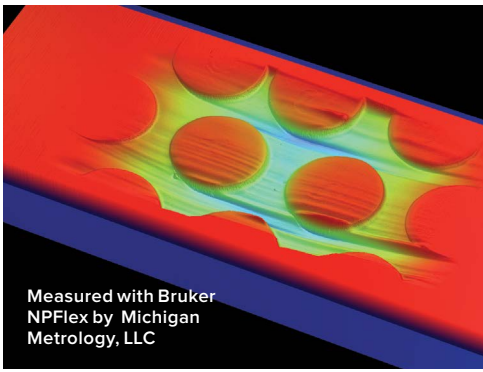
G02 ON WEAR AND EROSION — 1964 - 2024
WWW.ASTM.ORG/GET-INVOLVED/TECHNICAL-COMMITTEES/COMMITTEE-G02

G02 on Wear and Erosion
60th Anniversary

2024 marks the 60th anniversary of ASTM International's most abrasive committee: the committee on Wear and Erosion (G02). The committee was approved by the ASTM board of directors on Sept. 17, 1963, with the first meeting being held the following February. The original founders of G02 were from Westinghouse and involved in the Power Generation - Steam Turbine Division. Originally known as Committee G02 on Erosion by Cavitation or Impingement, G02 was renamed Wear and Erosion in 1972. The world is a much different place now than it was in 1963, but throughout the decades, G02 has proven to be a reliable source of standards, responding to ever-changing industry needs and new tribological discoveries.

The G02 official main scope notes that we are committed to "The promotion of knowledge, stimulation of research, formulation of terminology, guides, practices, and development of standard methods of testing data analysis." G02 members certainly pride ourselves with the advancement of tribology. Mundane topics like terminology turn into stirring, intellectually stimulating and thoughtful philosophical conversations. A favorite is, "What is Wear?" and the years long definition discussions.

Tribology has been around since the dawn of time.... or at least until matter condensed into existence. It just took 'til 1493 and Leonardo da Vinci to document this phenomenon. Tribology is EVERYWHERE. One of the most interdisciplinary fields, incorporating: mechanical engineering, material science, biology, chemistry, metrology, and physics. G02 examines the interaction of material systems. We look for wear, erosion, and friction characteristics to assist every industry in solving problems: automotive, mining, digging, medical, aerospace, oil & gas, petrochemical, sports/athletics, pharmaceutical, and power generation, the list goes on and on. Over 20% of the world's energy output is due to the impact of Tribology.



Measured with Bruker NPFlex by Michigan Metrology, LLC

As our work is so interdisciplinary, we routinely coordinate with other ASTM committees and other organizations having mutual interests, including ASTM Committees G01 on Corrosion of Metals and D02 on Petroleum Products and Lubricants, ASMI, ASME, SAE, STLE, ISO, and others.

WE ARE COMMITTED TO THE PROMOTION OF KNOWLEDGE, STIMULATION OF RESEARCH, FORMULATION OF TERMINOLOGY, GUIDES, PRACTICES, AND DEVELOPMENT OF STANDARD METHODS OF TESTING DATA ANALYSIS.

Commentary

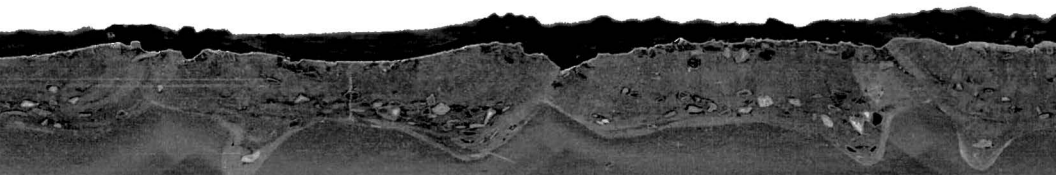
BY PETER BLAU, G02 MEMBER SINCE 1980

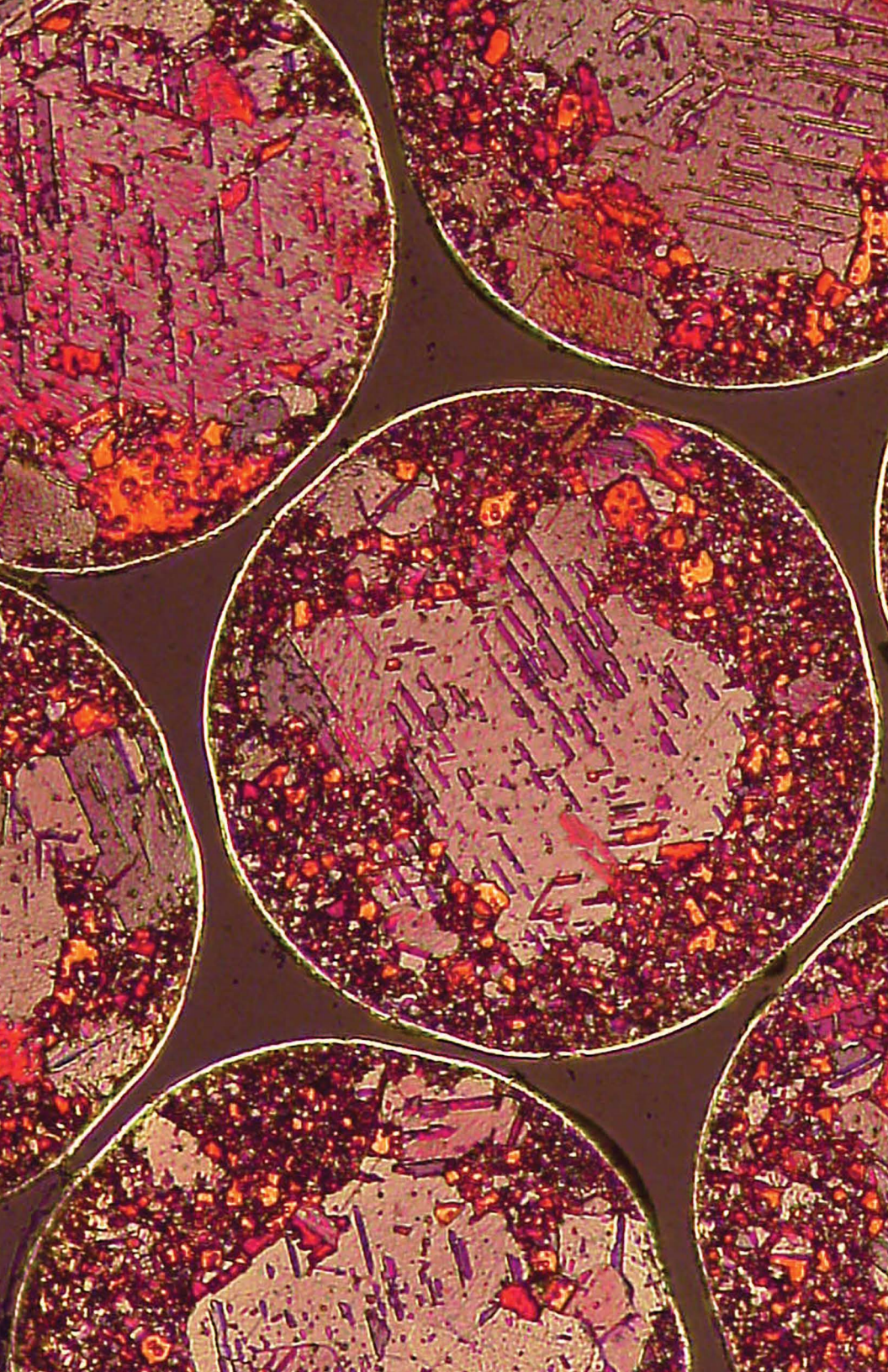
I can vividly remember my first ASTM committee week. It was in the fall of 1979. At that time, I was a new hire in the Metallurgy Division of what was then called the National Bureau of Standards. My group leader, Dr. Bill Ruff, was an avid G02 participant. Four members of Bill's group headed south for what was to be my first ASTM committee week, in Williamsburg, Virginia. They were Kirit Bhansali, Lew Ives, Bill, and me. After registering at the reception desk, we headed for the subcommittee meetings. On the way, I came across a sign that not only listed G02's subcommittee on terminology (chaired by Lew Ives at the time), but above it was another committee listing: "Toxic Waste Luncheon." It was then I knew that ASTM was for me.

The 'secrets of wear testing' which I learned through ASTM participation have proven valuable throughout my career. I had the opportunity to work with founding member Frank Heymann who encouraged me to join the ASTM Committee on Terminology which met at 1916 Race Street in downtown Philadelphia. I remember that famous address, and the narrow building that served as society headquarters before moving to West Conshohocken. Composed of a dozen or so senior folks from multidisciplinary technical committees, COT was great fun. They, along with Dick Strehlow from ORNL, nurtured my abiding interest in words, and I served for several years as the chair of G02.91.

Over the years, the thing that drew me most into the G02 fold was the willingness of members to share experiences from a shirtsleeve, nuts- 'n-bolts perspective of the practical aspects of wear testing. It was all about running tests 'the right way.' Very few professional groups delve not only into what methodology works but also what doesn't. Over 45 years, I have very much appreciated the camaraderie, education, and the opportunity to tour so many interesting places. In addition, I want to offer a shout out to ASTM staff like Jennifer Tursi, Alyson Fick, Jimmy Farrell, Tom O'Toole, Brian Milewski, Kathy Morgan, and many other friendly folks who lent lend their support and kept us researchers on track. In addition to the society staffers and the NBS crew, I would like to include a note of appreciation to mentors like Ken Budinski, Mike Anderson, Steve Shaffer, Mark Gee, George Plint, Ian Hutchings, Hector Clark, and many more to mention.

It is hard to believe I have been a member of G02 for almost 45 years, and I hope I can share the many practical lessons I have learned – by just showing up!





Commentary

BY KEN BUDINSKI, G02 MEMBER SINCE 1972

I joined G02 in the 1970s or thereabouts after I took a wear course taught by Ken Ludema from the University of Michigan; he recommended joining G2 to learn some more. They were mostly fluid mechanics professors and steam turbine people like Frank Heymann who were involved. I recall Fred Hammett from the University of Michigan as a regular attendee, and he was a fluid mechanics course professor. Sometime in this era, the word "Tribology" was coined by the Institution of Mechanical Engineers in the UK. Gene Finkin was a committee member and as I recall he was the first Ph.D. Tribology graduate in the USA. I do not remember his university.

Cavitation and a smattering of fluid erosion was the committee's emphasis during the early years. The committee produced ASTM G32, the cavitation test that uses an ultrasonic transducer-generated cavitation field above the test specimen.

Ray Bayer from IBM produced the next standard: ASTM G56. Ray developed a test using a ball rubbing on a four-foot diameter steel drum covered with cloth printer ribbon. The test simulates a typewriter key striking a printer ribbon. IBM was wearing out check writers at the time and this test was used to screen materials that did the printing through a ribbon. The inks were abrasive.

Frank Brautigam from a company that made centrifuges (Pennwalt Corp) spent eight years getting the ASTM G65 dry sand rubber wheel test approved. Many G2 meetings were dominated by discussion on the sand nozzle and sand flow rate. This test went on to be G2's most used test.

John Miller was responsible for the ASTM G75 Miller number slurry erosion test. John was the principal of White Rock Engineering, and he developed the erosion test to screen materials of construction for major slurry pipelines. Some of the pipelines were hundreds of miles long. The test was modified by John's son, Jim Miller, to produce erosion ranking of materials for erosion resistance. The Miller number test ranked the abrasivity of slurries, not a material's slurry resistance. The erosion option uses the ASTM G65 sand.

Bill Adler, from an aerospace testing company in California was a prime mover behind the ASTM G73, the droplet erosion test. The standard is based upon the giant propeller rig at Wright- Paterson Air Force Base. Specimens are attached to the tip of a propeller powered by a two hundred hp motor and rotated at speeds simulating jet aircraft. The test specimens are eroded by controlled water droplets produced by hypodermic needles in a ring in the path of the propeller. The propeller was about six feet in diameter, but there are now a number of test rigs in Europe that use a smaller diameter propeller, (like, one meter) and a higher motor speed.

The next erosion standard, ASTM G76 arose from multiple sources, but the NBS in Gaithersburg Maryland was heavily involved. It is a test of the solid particle erosion resistance of materials. The room temperature standard is a 1 mm diameter tungsten carbide nozzle at 90° to a surface, 10 mm standoff and test surfaces are blasted by 50 µm alumina particles. The standard requires the development of an erosion curve. Nobody can afford to develop an erosion curve, so they mostly ask for a single test at a fixed velocity.

The ASTM G77 block-on-ring test was the Committee's first metal-to-metal wear test. The standard test uses a machine designed and built by Falex Corporation. In the test, a small solid block is dead-weight loaded tangentially against the outside diameter of a ball bearing race. The wear on the block and ring are the test metrics. Falex corp. makes standard blocks and rings from various materials. Tests can be run with fluid covering the contact. It can be heated, and the machine continuously monitors friction force, and the test is also used in testing dry film lubricants. Some Falex machines can produce contact forces in excess of six hundred pounds. This is a "heavy-duty" wear test.

The ASTM G81 jaw crusher abrasion test was developed by ESCO Corporation in Oregon. It uses a commercial gyratory rock crusher with test specimens replacing the normal crusher plates. The standard test crushes five hundred pounds of morainal gravel and the mass loss on the test plates is the test metric.

The ASTM G98 galling test was developed by Bill Schumacher of Armco Steel Company. Armco made stainless steel which is notorious for their galling tendencies. Bill invented a non-galling stainless steel called Nitronic and he tested lots of material couples to compare with his non-galling couple. The test metric is production of macroscopic excretions on the rubbed services.

The most popular metal to metal tests at that time was the pin-on-disk test (ASTM G99) which typically rubs a stationary ball on a rotating horizontal disk. The repeatability of the test was assessed by a very large interlaboratory test. Bill Ruff at NIST (NBS) obtained results from over thirty labs all over the world. This test is still widely used, but it is criticized because it is not does not simulate a tribosystem that is used in real machines. The ASTM G65 test was modified to become the ASTM G105 slurry erosion test. The Falex ASTM G65 test machine was modified with the chamber to hold 50 to 75 sand and water slurry. The test required using rubber wheels of three different hardnesses and this makes this test very expensive to run.

Like ASTM, Int'l, G02's members are our focus. Without our zany and intelligent members, we would not have advanced Tribological standards, guides, and testing methods since 1963. Our initial years were focused on power generation, cavitation, and erosion. In our 60 years, as wear science evolved into tribology, so did G02. The future will continue to evolve for ASTM G02. Our members will continue to wear down the problems, seek to erode out the confusion but always realize that friction is a slippery business.

G02 Standards

TEN OF THE ORIGINAL G02 STANDARDS ARE STILL ACTIVE WITHIN G02:

G32 — Standard Test Method for Cavitation Erosion Using Vibratory Apparatus - 1972

G40 — Standard Terminology Relating to Wear and Erosion - 1973

G65 — Standard Test Method for Measuring Abrasion Using the Dry Sand/ Rubber Wheel Apparatus - 1980

G73 — Standard Test Method for Liquid Impingement Erosion Using Rotating Apparatus - 1982

G75 — Standard Test Method for Determination of Slurry Abrasivity (Miller Number) and Slurry Abrasion Response of Materials (SAR Number)- 1982

G76 — Standard Test Method for Conducting Erosion Tests by Solid Particle Impingement Using Gas Jets - 1983

G77 — Standard Test Method for Ranking Resistance of Materials to Sliding Wear Using Block-on-Ring Wear Test- 1983

G81 — Standard Test Method for Jaw Crusher Gouging Abrasion Test- 1983

G98 — Standard Test Method for Galling Resistance of Materials - 1989

G99 — Standard Test Method for Wear and Friction Testing with a Pin-on-Disk or Ball-on-Disk Apparatus — 1990

NEWER STANDARDS PUBLISHED WITHIN G02 INCLUDE:

G203 — Standard Guide for Determining Friction Energy Dissipation in Reciprocating Tribosystems — 2010

G204 — Standard Test Method for Damage to Contacting Solid Surfaces under Fretting Conditions — 2010

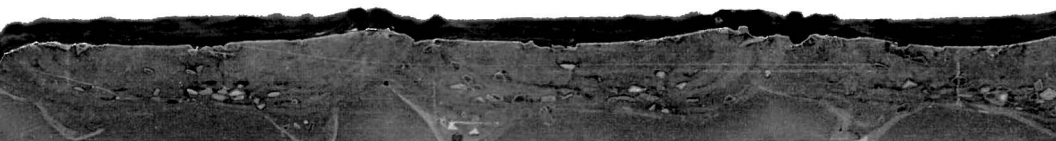
G206 — Standard Guide for Measuring the Wear Volumes of Piston Ring Segments Run against Flat Coupons in Reciprocating Wear Tests — 2011

G211 — Standard Test Method for Conducting Elevated Temperature Erosion Tests by Solid Particle Impingement Using Gas Jets - 2014

G219 — Standard Guide for Determination of Static Coefficient of Friction of Test Couples Using an Inclined Plane Testing Device - 2018

G223 — Standard Test Method for Measuring Friction and Adhesive Wear Properties of Lubricated and Nonlubricated Materials Using the Twist Compression Test (TCT) - 2023

The Committee, with a current membership of approximately one hundred, has jurisdiction of 34 standards, published in the *Annual Book of ASTM Standards,* Volume 03.02.



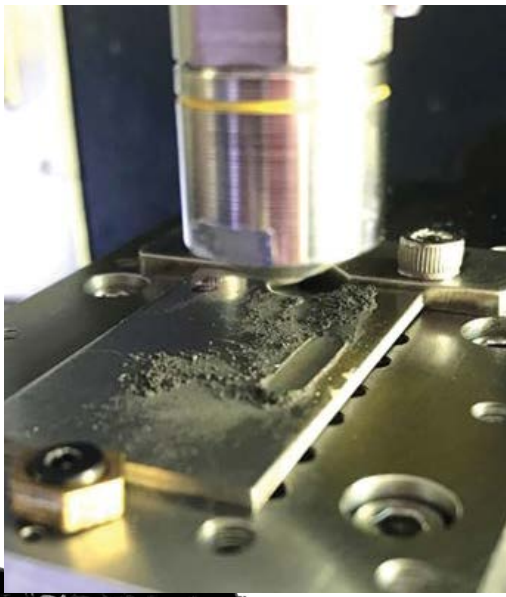
G02 STPs

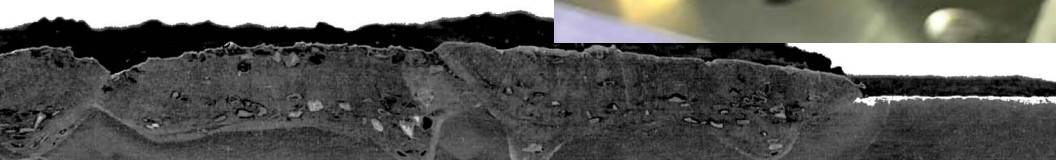
ASTM STP615-EB — "Selection of Wear Tests for Metals"- A symposium presented at November Committee Week in New Orleans, LA, November 1975 was edited by Ray Bayer from IBM. At that time Ray was promoting the concept of zero wear. He wrote a book on the subject. Fortunately, it did not end wear. Good thing, there would be no need for the G02 Committee.

ASTM STP1105-EB — "Tribological Modeling in Mechanical Designers", contains papers presented at the symposium of the same name held in San Francisco, CA, May 1990. Professor Kenneth C Ludema of the University of Michigan and Raymond G. Bayer of IBM. Ken Ludema was the founding father of the ASTM G02 Committee. At that time Ken was in search of a first-principal equation for the various forms of wear. He gave a paper with about two hundred different wear equations, and all contained some experimentally determined constant or other factor. This STP contained papers on the use of finite element techniques for analyzing tribosystems.

ASTM STP1563-EB — "Tribo-Corrosion: Research, Testing, and Applications", contains peer-reviewed papers that were presented at a symposium held in Atlanta, GA, April 2012. The Symposium Co-Chairpersons were Dr. Peter J. Blau, Oak Ridge National Laboratory, Oak Ridge, TN, USA, and Dr. Friedrich Franek, AC2T Research GmbH, Wiener Neustadt, Austria. The STP Editors are Dr. Peter J. Blau, Professor Jean-Pierre Celis, and Dr. Dirk Drees.

Margaret Stack from the UK and others were exploring the use of potentiodynamic polarization equipment combined with a wear tester. One could determine the synergy between wear and corrosion. Currently this type of testing is being done under the name of "Biotribology," since the most important wear couples in corrodents are in human joints.





G02 Committee Scopes

G02 ON WEAR AND EROSION

The promotion of knowledge, stimulation of research, formulation of terminology, guides, practices, and development of standard methods of testing data analysis. The activities relate to wear, friction, and erosion, which may include forms of surface damage of materials and structures.

The areas of interest of the Committee shall be the response of solids to mechanical interactions that occur due to relative motion between a solid material and a contacting substance or substances. This includes surface-to-surface or particle-to-surface sliding or rubbing, flow of fluids or slurries, impingement by liquid jets, drops, or solid particles, and cavitation of contacting liquids. These phenomena sometimes coexist, interact, or overlap with related phenomena, such as corrosion or lubrication. Where applicable and appropriate, the work of the Committee will be coordinated with other ASTM committees and other organizations having mutual interests, including ASTM Committees G01 on Corrosion of Metals and D02 on Petroleum Products and Lubricants, ASMI, ASME, SAE, STLE, ISO, and others.

TECHNICAL SUBCOMMITTEES

G02.10 on Erosion by Liquids and Solids

The function of this Subcommittee is to foster and develop standards to facilitate testing related to the erosion of materials caused by solid particle or liquid impingement, cavitation, electric-spark discharge, or by multiple-phase liquid-vapor flow or impingement. This shall include the development and evaluation of test methods, standard practices, guides, classifications, suggested reporting procedures, and reference documents as may be required, and the dissemination of pertinent information and results by sponsoring symposia and workshops

G02.30 on Abrasive Wear

The function of this Subcommittee is to foster and develop standards for measuring the resistance to facilitate testing related to the abrasion of materials to abrasion by rougher, harder counter faces and or/ loose, hard particles. The scope shall include the development and evaluation of abrasion test methods, standard practices, guides, and suggested reporting procedures. The role of the Subcommittee further includes the promotion of knowledge and education through the sponsorship and organization of workshops and symposia, and the dissemination of information through publications in related areas.

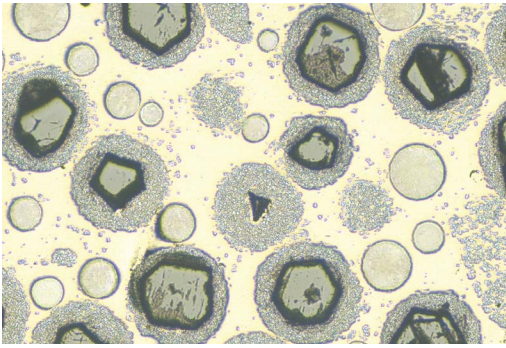
G02.40 on Non-Abrasive Wear

The function of this Subcommittee is to develop standards dealing with the test methods, testing procedures, and recommended practices related to forms of wear

which are not specifically covered by other subcommittees. These forms include adhesive wear, corrosive wear, fatigue wear, and fretting wear, either alone or in combination. The role of the Subcommittee further includes the promotion of knowledge and education through the sponsorship and organization of workshops and symposia and the dissemination of information through publications in related areas.

G02.50 on Friction

The function of this Subcommittee includes the development of methods for friction testing of materials, and the analysis of the data that such tests produce. It includes the formulation of associated terms and definitions. Further goals of this Subcommittee are to promote knowledge, stimulate research, solve friction problems, and validate models for the friction of materials.



G02.91 on Terminology

The function of this Subcommittee is to develop and coordinate terminology, including definitions, abbreviations, and descriptions of terms used in, and relevant to, standards developed by Committee G02. This Subcommittee has jurisdiction over the committee's terminology standard (G40) but may undertake additional wear terminology activities that fall within the scope of G02. The committee is governed by the Form and Style for ASTM Standards and other matters referred to by COS (Committee on Standards).

ADMINISTRATIVE SUBCOMMITTEES

G02.90 Executive

The function of this Subcommittee is to provide overall guidance for the activities of the Committee as a whole, and for areas of activity by the individual Subcommittees; to provide approval of task group organizations, to seek new areas of endeavor for the Committee, to establish policy guidelines as required, and to set goals for the Committee.

G02.93 Editorial

The function of this Subcommittee shall be to review and assist the subcommittees with Form and Style and technical information of standards that are developed. The technical Subcommittees are expected to use the ASTM Form and Style Manual. It is the responsibility of the Subcommittee Chairs to submit the draft for review by the Editorial Subcommittee before balloting if required.

G02 Honors and Awards

CHARLES B. DUDLEY MEDAL AWARD

An award presented in order to stimulate research leading to standardization, extend knowledge in a specific field of interest to the Society, and recognize meritorious contributions to the publications of the Society.

Frank Heymann, 1968

FRANK C. BRAUTIGAM AWARD

This is a G02 Committee award presented for outstanding and effective work, as a task group chair, in developing a new ASTM standard, as exemplified by Frank C. Brautigam, who was Chair of an Abrasive Wear Task Group (G02.30.02) from 1975 to 1986.

John Miller, 1989

Kenneth Budinski, 1996

Peter Blau, 1997

A Lichtarowicz, 1998

Frank Heymann, 2007

Scott Hummel, 2009

Gareth Fish, 2023

Teddy McClure, 2023

FRANK J. HEYMANN DSA

An award given to recognize outstanding and sustained service to Committee G02 on Wear and Erosion. This is a technical committee award.

Frank Heymann, 2000

Kenneth Budinski, 2003

Steven Shaffer, 2009

John Hadjioannou, 2017

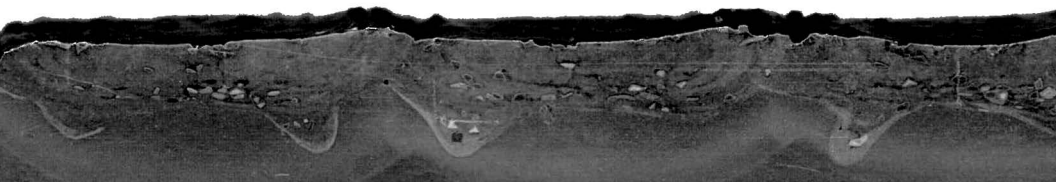
Troy LeValley, 2018

Brian Merkle, 2018

CERTIFICATE OF APPRECIATION

This is a G02 Committee award given for unusual or special service to the Committee as affirmed by a majority vote of the Executive Subcommittee. Examples of such services include efforts to develop a new standard, efforts to organize and conduct significant symposia, and efforts leading to ASTM STPs or other publications.

Kenneth Ludema, 2004



AWARD OF APPRECIATION

This award was established to recognize significant contributions to Committee G02, one of its subcommittees or one of its activities. The contribution may be for a significant specific effort or for consistent contributions of a sustained nature over a period of time.

Dilip Chaudhuri, 1998
Brian Hotlkemp, 1998
Andrew Phelps, 2009
Paul Swanson, 2009
Frank Heymann, 2011
Peter Blau, 2012
Jimmy Farrell, 2019

OUTGOING CHAIR AWARD

A member who has completed their term as Chair.

Peter Blau, 2004
Steve Shaffer, 2019

AWARD OF MERIT

A Committee member may qualify for this award on the basis of significant contributions within the Committee itself. It is the highest Society award granted to an individual member for distinguished service and outstanding participation in ASTM committee activities. Recipients also receive the honorary title of Fellow.

Frank Heymann, 1976
Frederick Hammitt, 1979
George Schmidt, 1981
Arthur Ruff, 1989
Kenneth Budinski, 1990
Raymond Bayer, 1992
Floyd Wood, 1996
Shyam Bahadur, 1999
Peter Blau, 2001
Scott Hummel, 2014
Steve Shaffer, 2020

LIFETIME EXCELLENCE

The Lifetime Achievement Award is to recognize lasting and significant contributions and exceptional service over many years to Committee G02, its subcommittees and/or activities. It is the highest award presented by Committee G02. The award may be granted posthumously.

Ken Budinski, 2024
Peter Blau, 2024

G02 Officer History

CHAIRS

1964-1970	J. Z. Lichtman
1970-1974	F. G. Hammitt
1974-1976	A. Thiruvengadam
1976-1980	G. F. Schmitt, Jr
1980-1982	K. C. Ludema
1982-1984	A. W. Ruff
1984-1986	F. J. Heymann
1986-1988	K. G. Budinski
1988-1990	R. G. Bayer
1990-1992	F. W. Wood
1992-1994	P. A. Swanson
1994-1995	Shyam Bahadur
1996-1999	J. H. Magee
2000-2004	D. J. Blau
2004-2005	B. M. Holtkamp
2006-2007	S. J. Shaffer
2008-2013	Scott Hummel
2014-2019	Steven Shaffer
2020- Present	John Hadjioannou

VICE-CHAIRS

1964-1970	F. G. Hammitt
1970-1974	E. J. Heymann
1974-1979	K. C. Ludema
1979-1982	A. W. Ruff
1982-1986	K. G. Budinski
1986-1988	R. G. Bayer
1988-1990	F. W. Wood
1990-1992	P. A. Swanson
1992-1994	Shyam Bahadur
1994-1995	J. H. Magee
1996-1999	P. J. Blau
2000-2001	J. D. Miller
2002-2003	B. M. Holtkamp
2004-2005	S. J. Shaffer
2006-2008	D. J. Blau
2008-2017	G. M. Dalton
2018-2019	John Hadjioannou
2020-2023	Brian Merkle
2024- Present	Kora Farokhzadeh

SECRETARIES

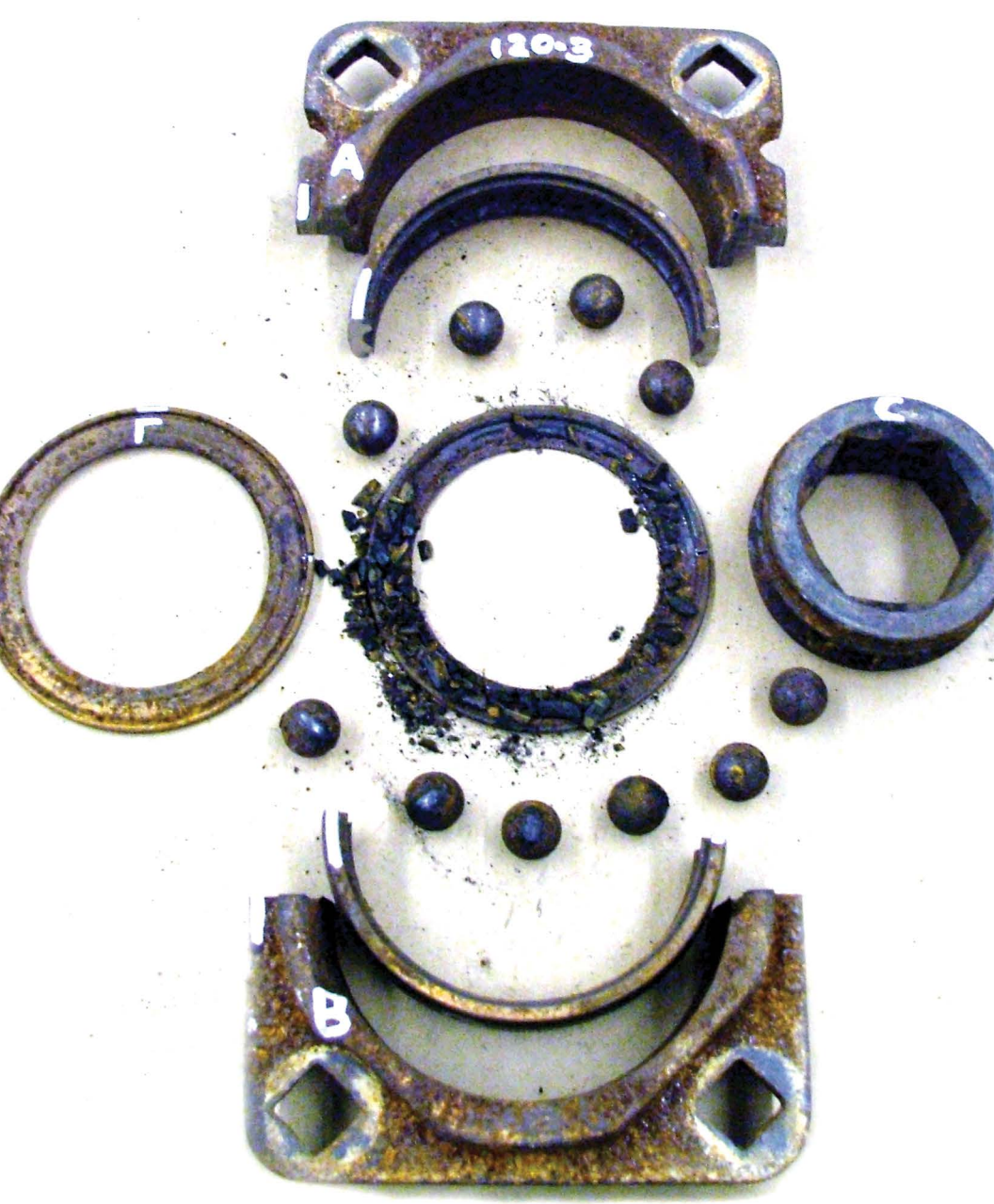
1964-1968	S. W. Doroff
1968-1969	G. J. Tatnall
1969-1970	J. C. Freche
1970-1972	F. C. Gilman
1972-1976	G. F. Schmitt, Jr
1976-1982	C. W. Gremman
1982-1986	R. G. Bayer
1986-1988	F. E. Schmidt
1988-1990	P. A. Swanson
1990-1994	J. H. Magee
1994-1995	Javaid Oureshi
1996-1998	Hector Clark
1998-2001	B. M. Holtkamp
2002-2003	Steven Shaffer
2004-2008	Scott Hummel
2008-2012	Michael Anderson
2012-2013	Troy Levalley
2013- 2016	Brian Merkle
2017- 2022	Scott Hummel
2023- 2024	Kora Farokhzadeh
2024- Present	Tom Slatter

MEMBERSHIP SECRETARIES

1979-1980	F. J. Heymann
1980-1982	R. G. Bayer
1982-1983	R. A. Sturley
1983-1984	S. R. Brown

MEMBERS-AT-LARGE

2024- Present	Andrew Hutchinson



ASTM Committee G02

Wear and Erosion

www.astm.org/get-involved/
technical-committees/committee-G02

ASTM INTERNATIONAL
Helping our world work better

Committed to serving global societal needs, ASTM International positively impacts public health and safety, consumer confidence, and overall quality of life. We integrate consensus standards — developed with our international membership of volunteer technical experts — and innovative services to improve lives...Helping our world work better.

ASTM INTERNATIONAL HEADQUARTERS

100 BARR HARBOR DRIVE
P.O. BOX C700
WEST CONSHOHOCKEN, PA 19428-2959
USA

TEL +1.610.832.9500
WEB GO.ASTM.ORG