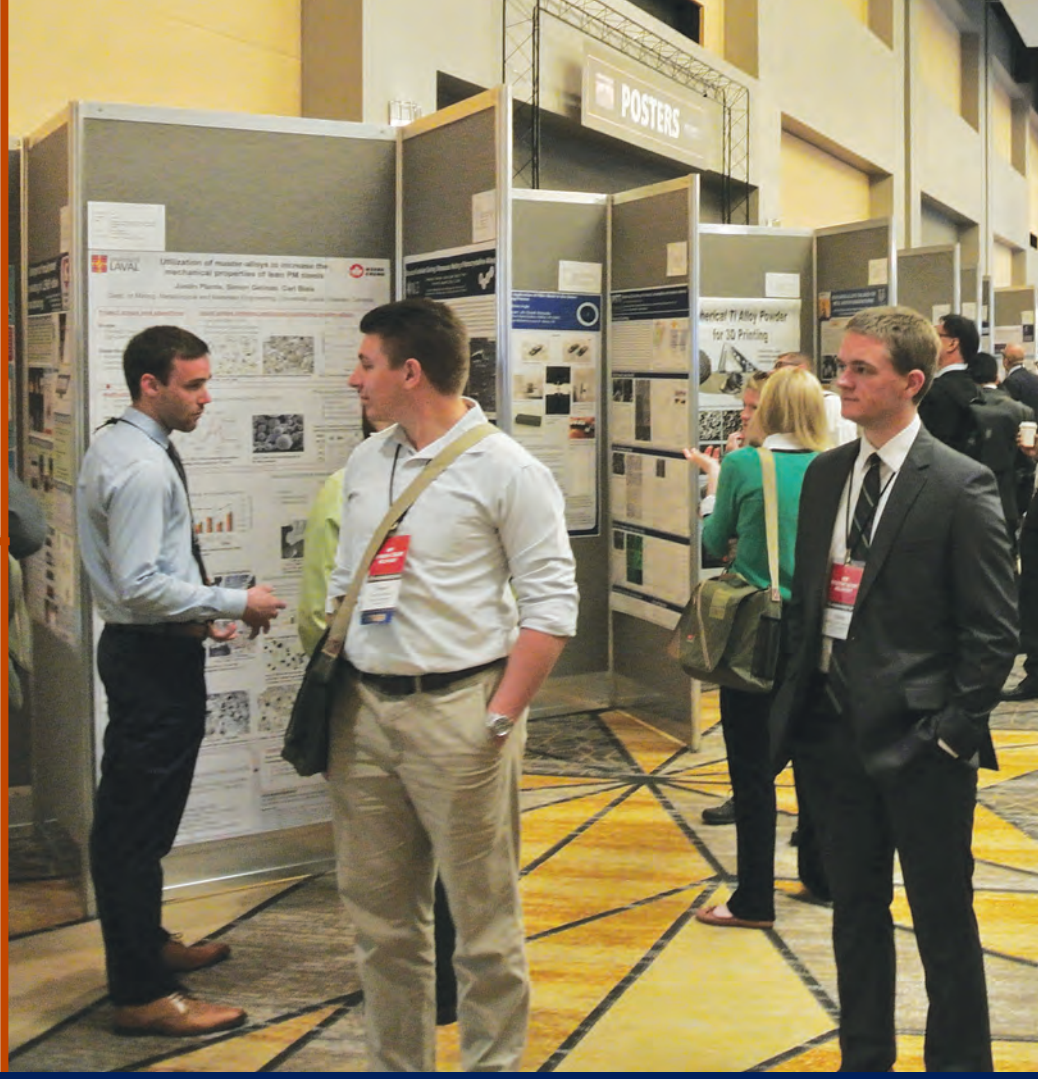

Two Big Conferences Under One Roof!

POWDERMET2019 Phoenix

International Conference
on Powder Metallurgy
& Particulate Materials

AM2019PM
Additive Manufacturing With Powder Metallurgy

Additive Manufacturing
with Powder Metallurgy

PROGRAM & REGISTRATION INFORMATION

June 23–26, 2019
Sheraton Grand • Phoenix, Arizona

Metal Powder Industries Federation
APMI International

For program details visit: POWDERMET2019.org or AMPM2019.org

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ABOUT KYMERA INTERNATIONAL:
With 9 manufacturing sites in 7 countries, Kymera International is a global leading producer and distributor of powders, pastes and granules of aluminum, aluminum alloys, copper, copper oxide, bronze, brass, tin, zinc, silver coated, antimony, bismuth, magnesium, manganese sulfide, MIM ferrous materials and several specialty alloys.

Celebrating 75 years of service to the powder metallurgy industry, the Metal Powder Industries Federation and its six trade associations have worked to advance the interests of the metal powder producing and consuming industries. Since 1944, MPIF has been a champion of PM and continues to provide member companies with valuable services to advance the art and science of PM while promoting technological benefits to prospective end users.

International Conference on Powder Metallurgy & Particulate Materials

Additive Manufacturing with Powder Metallurgy

TECHNICAL PROGRAM
Full conference registration provides access to both POWDERMET2019 and AMPM2019 technical sessions. Over 200 presentations from worldwide industry experts on the latest in powder metallurgy, particulate materials, and metal additive manufacturing. Visit POWDERMET2019.org or AMPM2019.org to find the latest conference program with complete abstracts, a schedule of events, and an exhibitor listing.

EXHIBIT
Over 100 booths showcasing leading suppliers of powder metallurgy and particulate materials processing equipment, powders, and metal additive manufacturing products.

SPECIAL CONFERENCE EVENTS
Including special guest speakers, luncheons, the Opening Night Reception, the PM Evening Alehouse, and the Closing Event—Rhinestone Rodeo!

Sponsored by:

Metal Powder Industries Federation
APMI International

Membership in either organization is not required for conference participation.

MPIF is an international federation of independent and related trade associations representing companies engaged in various aspects of the powder metallurgy and particulate materials industries. MPIF includes the following trade associations:

- Powder Metallurgy Parts Association
- Metal Powder Producers Association
- Powder Metallurgy Equipment Association
- Refractory Metals Association
- Metal Injection Molding Association
- Association for Metal Additive Manufacturing

APMI International is a worldwide technical society for professionals interested in developments in powder metallurgy and particulate materials technology.

REGISTER ONLINE AT POWDERMET2019.org or AMPM2019.org

CONTENTS

DAILY SCHEDULE

SUNDAY, JUNE 23

8:00 a.m.–2:00 p.m.
APMI GOLF TOURNAMENT
Troon North Golf Course
(Open to all attendees. Separate registration fee applies. Transportation departs from the Sheraton Grand lobby at 6:30 a.m.)

8:00 a.m.–5:00 p.m.
EXHIBITOR SETUP

2:00–6:00 p.m.
POSTER DISPLAY
(Author set-up)

Noon–6:00 p.m.
REGISTRATION OPEN

1:30–4:30 p.m.
METAL AM TUTORIAL
See Tutorial description on page 5.
(Open to all attendees. Separate registration fee applies.)

6:00–7:30 p.m.
OPENING NIGHT RECEPTION

Welcome to POWDERMET2019 & AMPM2019!

Join us as we kick-off the conferences as well as the 75th Anniversary celebration of MPIF! This casual opening reception will give you an opportunity to renew your acquaintances and network with your fellow PM/AM industry colleagues. Light food and beverages will be served as we welcome you to the Valley of the Sun, Phoenix!

MONDAY, JUNE 24

7:00–7:30 a.m.
SPEAKER PREP FOR MONDAY SPEAKERS

7:00 a.m.–5:30 p.m.
REGISTRATION

7:00 a.m.–5:30 p.m.
PUBLICATIONS BOOTH

8:00–9:15 a.m.
OPENING GENERAL SESSION

This conference opening session will feature welcome comments from MPIF Executive Director/CEO James P. Adams and MPIF President John F. Sweet, PMT. An overview of the annual MPIF State of the Industry report highlighting industry business conditions, technology trends, and the market for powder metallurgy and particulate materials will also be presented.

Keynote Presentation:

Connecting Dots in the Metal Powder World

Bill Stainton
Emmy Award-winning TV producer, writer, performer, and author

In the competitive metal powder industry, challenging problems require innovative solutions. And coming up with innovative solutions requires creative ideas. But where do these creative ideas come from? And how can we, as metal powder industry leaders, come up with them—effectively and on-demand? In this entertaining and enlightening program, multiple Emmy Award winner Bill Stainton will show us that creative ideas are not a function of the "lightning bolt" from above; they're a function of connecting dots.

9:30–10:45 a.m.
POWDERMET TECHNICAL SESSIONS
01: Ferrous Materials & Properties I
02: Atomization I
03: Sintering Furnace Design and Atmospheres

SPECIAL INTEREST PROGRAM
SIP 1: Additive Machines, Capabilities and Processes

AMPM TECHNICAL SESSIONS
A01: Alloy Development
A02: Process and Properties
A03: Characterization Methods for AM Powders and Components

9:30–11:45 a.m.
EXHIBIT OPENS
POSTER DISPLAY
AM CAFÉ: *Coffee Served*

10:15–11:45 a.m.
POWDER METALLURGY PARTS ASSOCIATION
Membership Meeting

11:00–11:45 a.m.
GRANT TNT: Talk 'N Technology—Part 1

Noon–1:45 p.m.
PM DESIGN EXCELLENCE AWARDS LUNCHEON

This annual luncheon will highlight winners in the 2019 PM Design Excellence Awards Competition.


2018 Grand-Prize Winners

(Stop in the exhibit hall after lunch to view the winning parts.)

1:45–2:45 p.m.
PM CAFÉ: *Desserts Served*

1:45–7:00 p.m.
EXHIBIT OPEN
POSTER DISPLAY

2:00–3:00 p.m.
GRANT TNT: Talk 'N Technology—Part 2

TUESDAY, JUNE 25

3:00–4:15 p.m.
POWDERMET TECHNICAL SESSIONS
04: Ferrous Materials and Properties II
05: Atomization II

AMPM TECHNICAL SESSIONS
A04: Nickel Alloys I
A05: Solid-State Processing
A06: Modeling of Metal AM I

3:00–4:15 p.m.
MANAGEMENT SESSION—
PM Industry Trends: Management Economic Indicators

4:30–5:45 p.m.
MANAGEMENT SESSION—
Implementing a Cultural Change: The Development of High-Performance Organization

4:30–5:20 p.m.
CPMT PRESENTATIONS—
Evaluation of Acoustical Mixing and Rust Prevention of PM Ferrous Parts

4:30–5:45 p.m.
AMPM TECHNICAL SESSIONS
A07: Nickel Alloys II
A08: Exploratory Metal Powder Production
A09: Modeling of Metal AM II

5:20–5:45 p.m.
PM TECHNOLOGY SCAN 2019—Improvement in Precision/ Accuracy/Variaton Control

5:30–7:00 p.m.
PM EVENING ALEHOUSE
Sponsored by the Powder Metallurgy Equipment Association (PMEA)

MPIF and PMEA invite all registered delegates to the exhibit hall for 90 minutes of uninterrupted networking while you enjoy a glass of wine or a cold beer. Walk through the hall and visit with exhibitors to find out more about their products and services. It is also a great opportunity to get your Exhibitor Game Card filled out for a chance to win one of our grand prizes!

Poster Authors will also be available for discussion.

7:00–7:30 a.m.
SPEAKER PREP FOR TUESDAY SPEAKERS

7:00 a.m.–5:00 p.m.
REGISTRATION

7:00 a.m.–5:00 p.m.
PUBLICATIONS BOOTH

7:30–8:30 a.m.
POWDER METALLURGY EQUIPMENT ASSOCIATION
Membership Meeting

8:00–9:15 a.m.
POWDERMET TECHNICAL SESSIONS
06: Ferrous Materials and Properties III
07: MIM I
08: Non-Traditional Alloy Sintering

SPECIAL INTEREST PROGRAM
SIP 2-1: Powder Production for AM, PM, MIM: Differences, Similarities and Synergies

AMPM TECHNICAL SESSIONS
A10: Aluminum Alloys
A11: NDT Methods Applied to AM Powders and Components
A12: Metal AM: Processes and Applications

9:00–10:30 a.m.
AM CAFÉ: *Coffee Served*

9:00–11:45 a.m.
EXHIBIT OPENS
POSTER DISPLAY

9:30–10:30 a.m.
GRANT TNT: Talk 'N Technology—Part 3

10:30–11:45 a.m.
POWDERMET TECHNICAL SESSIONS
09: Ferrous Materials and Properties IV
10: MIM II
11: Modeling I

SPECIAL INTEREST PROGRAM
SIP 2-2: Powder Production for AM, PM, MIM: Moving Away from Two-Fluid Atomization

AMPM TECHNICAL SESSIONS
A13: Biomedical Applications
A14: Recycling of AM Powders I
A15: Process Enhancement and Monitoring

Noon–1:45 p.m.
INDUSTRY LUNCHEON
Recognizing PM Industry Achievements
The luncheon will recognize key industry individuals identified to receive major industry awards, among them the MPIF Distinguished Service to Powder Metallurgy Award and APMI's new Class of Fellows, Joseph T. Strauss and John L. Johnson.

1:45–3:15 p.m.
PM CAFÉ: *Desserts Served*

1:45–4:30 p.m.
EXHIBIT OPENS
POSTER DISPLAY

2:00–3:15 p.m.
GRANT TNT: Talk 'N Technology—Part 4

3:15–4:30 p.m.
POWDERMET TECHNICAL SESSIONS
12: Advanced Particulate Materials
13: Novel Sintering
14: Modeling II

SPECIAL INTEREST PROGRAM
SIP 2-3: Powder Production for AM, PM, MIM: Process Characterization, Parameters and Design

AMPM TECHNICAL SESSIONS
A16: Organic Binder Based AM
A17: Recycling of AM Powders II
A18: Effect of AM Process on Mechanical Properties

DAILY SCHEDULE

Tuesday continued

6:00–10:00 p.m.
CLOSING EVENT—Rhinestone Rodeo!
Join us for an adventure of a lifetime, as we head to Corona Ranch for the Closing Event—Rhinestone Rodeo! The group will enjoy an interactive cocktail reception where networking will be the top priority. The group will then be invited to watch the exhilarating Charreada (Mexican Rodeo) and Western Rodeo show. For dinner, join us for a fiesta that will be sure to WOW your senses! Surprises will be awaiting you at every turn—and you won't want to miss this unforgettable Closing Event.

Dress attire is casual. Shorts are permitted as this event will be held partially outdoors.

WEDNESDAY, JUNE 26

7:00–7:30 a.m.
SPEAKER PREP FOR WEDNESDAY SPEAKERS

7:00 a.m.–12:15 p.m.
REGISTRATION

7:00 a.m.–12:15 p.m.
PUBLICATIONS BOOTH

8:00–9:15 a.m.
POWDERMET TECHNICAL SESSIONS
15: Furnace & HIP Technology
16: Refractory Materials
17: Densification

SPECIAL INTEREST PROGRAM
SIP 3-1: Machinery Sensors & Information Technology: Industry Sensors I—I'm Looking for Data

AMPM TECHNICAL SESSIONS
A19: Tribology and Corrosion
A20: Powder Characterization for AM
A21: Binder Jetting of Metal Powder

9:30–10:45 a.m.
POWDERMET TECHNICAL SESSIONS
18: Material Processing
19: Compacting Development and Optimization
20: PM Applications

SPECIAL INTEREST PROGRAM
SIP 3-2: Machinery Sensors & Information Technology: Industry Sensors II—Let's Organize the Data

AMPM TECHNICAL SESSIONS
A22: AM Powder Flow Characterization
A23: Design of Metal AM Structures
A24: Copper-Based AM

11:00 a.m.–12:15 p.m.
POWDERMET TECHNICAL SESSIONS
21: Powder Test & Evaluation
22: Secondary Operations
23: Safety and Management

SPECIAL INTEREST PROGRAM
SIP 3-3: Machinery Sensors & Information Technology: Industry Sensors III—Impacting Business Operations with My Data

AMPM TECHNICAL SESSIONS
A25: Sintering of AM Materials
A26: Metal AM Post Processing

12:30–1:30 p.m.
CONFERENCE COMMITTEE MEETING
(By invitation)

2:00–5:00 p.m.
ASSOCIATION FOR METAL ADDITIVE MANUFACTURING
Membership Meeting

POWDERMET2019/AMPM2019 CONCLUDES
(Program, times and events subject to change)

RESTRICTIONS ON RECORDING
No photography, or audio or video recording of presentations is permitted.

NEW THIS YEAR!

Metal AM Tutorial

Optional Metal Additive Manufacturing Tutorial

Sunday, June 23 (1:30–4:30 p.m.)

Conducted by: Todd A. Palmer, The Pennsylvania State University
Joseph T. Strauss, FAPMI, HJE Company, Inc.

(Separate registration fee applies.)

This tutorial will provide a basis for determining process options, uses, properties, applications, and opportunities for cost-effective metal additive manufacturing (AM). Individuals who will benefit from the tutorial include engineers, business managers, procurement managers, component designers, and technicians. This course is a must for consumers of metal AM components and organizations that are exploring the opportunities associated with developing their own metal AM manufacturing facilities.

Registrants will receive a certificate of completion.

Included in the Tutorial:

- Overview of Metal AM Processes (Fusion and Solid State)
- Powder Feedstock Characteristics
- Fusion-Based Metal AM Processes:
  Beam-Material Interactions and
  Rapid Solidification Mechanisms
- Non-Fusion Metal AM Processes:
  Sintering and Solid-State Transformations
- Post-Processing, Properties and Performance

Distinguished Service to Powder Metallurgy Award

Recognizing individuals who have devoted a major part of their working careers (minimum 25 years) to one or more segments of the field of powder metallurgy and whose long-term contributions and achievements are such that, in the minds of their peers, they deserve this special recognition for outstanding and distinguished service.

(Presentations at Industry Luncheon on Tuesday.)

2019 RECIPIENTS

(Company name in parenthesis indicates employer at time of retirement)

Denis Christopherson, PMT
Federal-Mogul Powertrain

Zhigang (Zak) Fang, FAPMI
University of Utah

Robert M. Gasior
Arconic Technical Center

Ryuichiro Goto
(Engineered Sintered Components)

William A. Heath, PMT
(MPP)

Stephen J. Lanzel
Catalus Corporation

Deepak Madan
Luxfer Magtech

David Milligan
North American Höganäs Co.

Thomas Pfingstler
Atlas Pressed Metals

Daniel P. Reardon
Abbott Furnace Company

Christopher T. Schade
Hoeganaes Corporation

Michael Stucky
Norwood Injection Technologies, LLC

C. James Trombino, CAE
(Metal Powder Industries Federation)

EXHIBIT

Attend the PM industry's largest tradeshow devoted exclusively to powder metallurgy, particulate materials, and metal additive manufacturing. With over 100 booths, this international marketplace will present leading companies featuring the latest PM & metal AM equipment, powders, products, and services.

Meet industry suppliers all together in one place.

Here is what's happening in the 2019 Exhibit Hall…

Extended Exhibit Hall Hours
Open for over 12 hours, this year's hall includes nearly 7 hours of non-compete time.

PM Evening Alehouse
Enjoy a 90-minute networking reception while you tour the exhibit hall—with a glass of wine or cold beer in hand! Sponsored by the Powder Metallurgy Equipment Association.

Exhibitor Game Card—Your Chance to Win Up to $500 Returns
Complete your game card by filling in all 25 squares with stickers from different exhibitors. Turn in a completed game card for a Starbucks gift card and a chance to win one of three grand prizes!

AM/PM Café—Keep the Networking Going…
Meet up for a morning cup of coffee or grab dessert after lunch. Then, tour the exhibit hall.

Poster Display—Bringing Learning into the Hall
Poster authors will be on hand to discuss their posters during the PM Evening Alehouse. To hear even more from the student grant recipients, attend the Grant TNT: Talk 'N Technology sessions.
(See Daily Schedule for details and times.)

Showcase of PM Excellence—
2019 PM Design Excellence Award Entries on Display
All entries will be on display in the exhibit hall, with winning parts to be identified following Monday's Awards Luncheon. This "Showcase of PM Excellence" provides an opportunity to review the latest PM engineering innovations and applications.

The marketing of goods and services at the conference is reserved solely for MPIF exhibitors and sponsors. People engaging in these practices who are NOT connected to an exhibit booth or sponsorship will be asked to leave the premises and will forfeit all registration fees.

Exhibit Hall Hours

Monday, June 24
9:30–11:45 a.m.
1:45–7:00 p.m.

Tuesday, June 25
9:00–11:45 a.m.
1:45–4:30 p.m.

(Listing as of January 25, 2019)

Exhibitors

ABBOTT FURNACE COMPANY
St. Marys, PA

ABTEX CORPORATION
Dresden, NY

AIR PRODUCTS AND CHEMICALS, INC.
Allentown, PA

ALD VACUUM TECHNOLOGIES, INC.
East Windsor, CT

AMERICAN CHEMET CORPORATION
East Helena, MT

AMETEK SPECIALTY METAL PRODUCTS
Eighty Four, PA

ANTON PAAR
Ashland, VA

ASBURY CARBONS
Asbury, NJ

ATI POWDER METALS
Oakdale, PA

BFG MANUFACTURING
Punxsutawney, PA

BLASCH PRECISION CERAMICS
Albany, NY

BRONSON & BRATTON, INC.
Burr Ridge, IL

BRUKER AXS
Madison, WI

CARPENTER TECHNOLOGY CORPORATION
Bridgeville, PA

CENTORR VACUUM INDUSTRIES, LLC
Nashua, NH

CHUNG YI MOLD (SUZHOU) CO., LTD.
Jiangsu Province, China

CINCINNATI INCORPORATED
Cincinnati, OH

CM FURNACES, INC.
Bloomfield, NJ

CNPC POWDER NORTH AMERICAN INC.
Vancouver, British Columbia, Canada

COOKSONGOLD
Birmingham, United Kingdom

DORST AMERICA, INC.
Bethlehem, PA

ELCAN INDUSTRIES
Tuckahoe, NY

ELNIK SYSTEMS, LLC
Cedar Grove, NJ

ENGINEERED LUBRICANTS CO.
Maryland Heights, MO

EROWA TECHNOLOGY, INC.
Arlington Heights, IL

EXONE
North Huntingdon, PA

FREEMAN TECHNOLOGY
Tewkesbury, United Kingdom

GASBARRE PRODUCTS, INC.
DuBois, PA

GENICORE
Warszawa, Poland

GERARD DANIEL WORLDWIDE
Hanover, PA

GFMS/SYSTEM 3R
Lincolnshire, IL

GLOBAL TUNGSTEN & POWDERS CORP.
Towanda, PA

GRANUTOOLS
Awans, Belgium

GUANG DONG CINCY MOULD & MACHINERY CO. LTD.
Dong Guan City, China

H.C. STARCK INC.
Euclid, OH

HARPER INTERNATIONAL
Buffalo, NY

HERDING FILTRATION LLC
Waterford, MI

HOEGANAES CORPORATION
Cinnaminson, NJ

HÖGANÄS
Hollsopple, PA

HORIBA INSTRUMENTS, INC.
Irvine, CA

IPS CERAMICS
Stoke-on-Trent, United Kingdom

KITTYHAWK PRODUCTS
Garden Grove, CA

KYMERA INTERNATIONAL
Research Triangle Park, NC

LECO CORPORATION
St. Joseph, MI

LINDE, LLC
Murray Hill, NJ

LINE CRAFT, INC.
Lombard, IL

LUXFER MAGTECH
Manchester, NJ

MAKIN METAL POWDERS (UK) LTD
Lancashire, UK

MALVERN PANALYTICAL
Westborough, MA

MICROCARE CORPORATION
New Britain, CT

NOVAMET SPECIALTY PRODUCTS CORPORATION
Lebanon, TN

ORS—OBJECT RESEARCH SYSTEMS
Montreal, Québec, Canada

ORTON CERAMIC FOUNDATION
Westerville, OH

OSTERWALDER INC.
Northampton, PA

PFEIFFER VACUUM
Nashua, NH

PLANSEE USA LLC
Franklin, MA

PRAXAIR SURFACE TECHNOLOGIES
Indianapolis, IN

PRAXAIR, INC.
Burr Ridge, IL

PRECISION EFORMING
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QUINTUS TECHNOLOGIES
Lewis Center, OH

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RIO TINTO METAL POWDERS
Sorel-Tracy, Québec, Canada

ROYAL METAL POWDERS INC.
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Palmerton, PA

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Belleville, NJ

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Newtown, PA

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Salem, OH

WUXI CITY SINCERE REFRACTORY CERAMICS CO., LTD.
Yixing City, China

TECHNICAL SESSIONS

Technical Program Listing as of January 25, 2019

- Presentation numbers are listed before the author's country identification.
- ***NEW!*** Repeat sessions will be indicated by having an "R" listed after the presentation number.
- Visit POWDERMET2019.org or AMPM2019.org for the most up-to-date information and to view submitted abstracts.

POWDERMET TECHNICAL SESSIONS

CONFERENCE CHAIRMEN:

Daniel Reardon
Abbott Furnace Company

Virendra Warke
Entegris Inc.

TECHNICAL FORMAT
Two to three technical sessions will take place concurrently.

Each session will consist of:
- Three technical papers presented by the author
- Individual presentation times will run 25 minutes, including questions

Manuscripts from the technical sessions will be included in the conference proceedings.

AMPM TECHNICAL SESSIONS

CONFERENCE CHAIRMEN:

Mathieu Brochu
McGill University

Juha Kotila
EOS Finland

TECHNICAL FORMAT
Two to three technical sessions will take place concurrently.

Each session will consist of:
- Three technical papers presented by the author
- Individual presentation times will run 25 minutes, including questions

Manuscripts from the technical sessions will be included in the conference proceedings.

GRANT TNT: TALK 'N TECHNOLOGY

Students who receive the National Science Foundation (NSF) Grant or the CPMT/Axel Madsen Conference Grant will present a 10-minute synopsis of their poster. Grant recipients and their poster titles will be available on the conference website.

SPECIAL INTEREST PROGRAM

Special Interest Program (SIP) presentations are cutting-edge R&D and typically oral in nature, but all submitted publishable manuscripts will be included in the conference proceedings.

RESTRICTIONS ON RECORDING
No photography, or audio or video recording of presentations is permitted.

POWDERMET2019 TECHNICAL PROGRAM COMMITTEE

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Wiley Abner
MPP
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Fiat Chrysler Automobiles
Chapin Paullin
Capstan California
Clayton Paullin, PMT
PM Engineered Solutions, Inc.
Thomas Pelletiers
Kymera International
Thomas Pfingstler
Atlas Pressed Metals
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Jenike & Johanson, Inc.
Daniel Reardon, *Co-Chairman*
Abbott Furnace Company
Eric Reinert
Bronson & Bratton, Inc.
Heron Rodrigues
Engineered Sintered Components
Rajendra Sadangi
Maria Sawford
Carpenter Powder Products
Raymond Serafini, PMT
Linde, LLC
Suresh Shah
Bryan Sherman
DSH Technologies, LLC
John Shields, FAPMI
PentaMet Associates LLC
Rohith Shivanath
Stackpole International
Brian Sieger
Honda R&D Americas
Michael Stawovy
H. C. Starck Inc.
Blaine Stebick
Phoenix Sintered Metals LLC
John Stenulis
Dorst America, Inc.
Thomas Stephenson
Rio Tinto Metal Powders
Craig Stringer
Atlas Pressed Metals
S. K. Tam
Ormco
Alan Taylor
GKN Sinter Metals
Yannig Thomas
National Research Council Canada
Amber Tims, PMT
North American Höganäs Co.
Pankaj Trivedi
Kennametal Inc.
Ronald Van Noort
Wire Mesh Belt Company
John von Arx
Phoenix Sintered Metals LLC
Richard Walker
Pressure Technology, Inc.
Gregory Wallis
Dorst America, Inc.
Virendra Warke, *Co-Chairman*
Entegris Inc.
Alexander Wartenberg
Hoeganaes Corporation
Roland Warzel III
North American Höganäs Co.
Dwight Webster
Advanced Metalworking Practices, LLC
Stephen Wendel
Gasbarre Products, Inc.
Gregory Thomas West, PMT
National Sintered Alloys, Inc.
Michael Wiseman
ARC Group Worldwide
David Wolf
Royal Metal Powders Inc.
Thomas Wright
Jet Metals, Inc.
Wenying Yang
General Motors Corporation
Dustin Yetzer
Abbott Furnace Company
Antonios Zavaliangos
Drexel University

AMPM2019 TECHNICAL PROGRAM COMMITTEE

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Quintus Technologies
Ronald Aman
Carpenter Technology Corporation
Iver Eric Anderson, FAPMI
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Sundar Atre
University of Louisville
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University of Tennessee College of Engineering
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GE Additive
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LPW Technology, Inc.
Stuart Jackson
Renishaw Inc.
Mary Kate Johnston
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Martin Kearns
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MPP
Aaron LaLonde
SLM Solutions NA Inc.
Hyrum Lefler
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ExOne
Sydney Luk
Deepak Madan
Luxfer Magtech
Michael Marucci
Ametek Reading Alloys
Ashley Nichols
3D Materials Technologies, LLC
Jerome Pollak
Tekna Advanced Materials, Inc.
Kirk Rogers
The Barnes Group Advisors
Ankit Saharan
EOS Finland
Mark Saline
Gasbarre Products, Inc.
Christopher T. Schade
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Joseph T. Strauss, FAPMI
HJE Company, Inc.
Michael Stucky
Norwood Injection Technologies, LLC
Katie Jo Sunday
Hoeganaes Corporation
Rajiv Tandon
Luxfer Magtech
Jason Ting
Thermal Technology LLC
Emma White
Ames Laboratory
Andrzej Wojcieszynski
ATI Powder Metals

Monday, June 24 TECHNICAL SESSIONS

POWDERMET TECHNICAL SESSIONS Monday Morning 9:30–10:45 a.m.

SESSION 01

Ferrous Materials and Properties I

Session Chairman:
Craig Stringer,
Atlas Pressed Metals

185 *USA* 9:30 a.m.
Development of High-Strength PM Alloy That Competes with Wrought 8620 Alloy in Structural Applications
Brad Morningstar,
MPP

182 *USA* 9:55 a.m.
Fatigue Performance of a Sinter-Hardened Powdered Metal Steel
Ian Donaldson, FAPMI,
GKN Sinter Metals

119 *USA* 10:20 a.m.
Effect of Reducing Nickel in Current PM Materials
Neal Kraus,
Hoeganaes Corporation

SESSION 02

Atomization I

Session Chairman:
John Meyer,
Carpenter Technology Corporation

103 *USA* 9:30 a.m.
Production and Characteristics of Atomized Submicrometer Alloy Powders
Randall M. German, FAPMI,
German Materials Technology

133 *USA* 9:55 a.m.
Comparison of Simulated and Experimental Observations of Pure Ni Gas Atomization: Surrogate for Development of Parameters to Produce Ni-Base Superalloy Feedstock Powders for AM
Trevor M. Riedemann,
Ames Laboratory (USDOE)

147 *USA* 10:20 a.m.
Results of Satellite Reduction Strategy on Gas-Atomized Powder Quality for Additive Manufacturing
Iver E. Anderson, FAPMI,
Ames Laboratory (USDOE)

SESSION 03

Sintering Furnace Design and Atmospheres

Session Chairman:
Kester Clarke,
Colorado School of Mines

158 *USA* 9:30 a.m.
Controlled Atmosphere Technologies for Sintering High-Quality Components by Proper Lubrication and Lean Sintering Atmospheres
Akin Malas,
Linde LLC

186 *USA* 9:55 a.m.
A Review of Lubricant Removal Systems and the Latest Technology
Stephen L. Feldbauer,
Abbott Furnace Company

059 *India* 10:20 a.m.
Precision Bronze Sintering Furnace Design
Ravi P. Malhotra, Sr.,
Malhotra Engineers

SPECIAL INTEREST PROGRAM — Monday Morning — 9:30–10:45 a.m.

SIP 1

Additive Machines, Capabilities and Processes

Program Organizers:
Joseph Capone, Ametek, Inc.
Stuart Jackson, Renishaw Inc.
Aaron LaLonde, SLM Solutions NA, Inc.

This program will consider the rapidly growing topic of additive manufacturing (AM) and aims to cover information relevant to the powder metal industry. Presentations will discuss the technologies of current interest in AM and highlight the value and advantages of the different processes and machines. Additional information to be shared includes identification of suitable applications and business case information to support use cases. The current state of AM will be shared, including industry activity, challenges, and ongoing developments to promote and enable manufacturing and industrialization of AM.

Session Chairman: Aaron LaLonde, SLM Solutions NA, Inc.

191 *USA* 9:30 a.m.
Additive Manufacturing for Growth Acceleration in the Powder Metallurgy Industry
Kirk Rogers,
The Barnes Group Advisors

203 *USA* 9:55 a.m.
Developing of Hot Isostatic Press (HIP) and Heat-Treating Cycles for 3D-Printed Aerospace Titanium
Francisco Medina,
UTEP/Keck Center

204 *USA* 10:20 a.m.
Process Maps for Powder Bed Fusion Based on Defect Densities
Jerard V. Gordon,
Carnegie Mellon University

AMPM TECHNICAL SESSIONS — Monday Morning — 9:30–10:45 a.m.

SESSION A01

Alloy Development

Session Chairman:
Animesh Bose, FAPMI,
Desktop Metal, Inc.

074 *USA* 9:30 a.m.
Development of 4600 Low-Alloy Steel for LPBF Applications
Kerri Horvay,
Hoeganaes Corporation

113 *USA* 9:55 a.m.
Microstructure, Mechanical Properties and Corrosion Resistance of Laser-Powder-Bed-Fusion Processed Duplex Stainless Steel
Sundar V. Atre,
University of Louisville

122 *USA* 10:20 a.m.
Ni-Based Superalloy Design & Validation for Additive Manufacturing Rapid Solidification Conditions
Emma M. White,
Ames Laboratory of USDOE

SESSSION A02

Process and Properties

Session Chairman:
Anit Giri,
U.S. Army Research Laboratory

092 *United Kingdom* 9:30 a.m.
Building High-Integrity Parts with Multiple Lasers
Marc Saunders,
Renishaw Inc.

174 *USA* 9:55 a.m.
Texture Evolution in Electron Beam Powder Bed Produced Ti-6Al-4V with Varying Build Strategies
Alec I. Saville,
Colorado School of Mines

116 *USA* 10:20 a.m.
Effects of Nitrogen Content in Properties and Microstructure of 420 Stainless Steel Fabricated by Laser-Powder Bed Fusion
Sundar V. Atre,
University of Louisville

SESSION A03

Characterization Methods for AM Powders and Components

Session Chairman:
Magnus Ahlfors,
Quintus Technologies

058 *Canada* 9:30 a.m.
Characterization of Triboelectrically Charged AM Metal Powder Using the Rotating Drum Technique
Eileen Ross L. Espiritu,
McGill University

163 *Belgium* 9:55 a.m.
Metallic Powders Thermal Degradation: Influence on Spreadablity, Packing Dynamics and Electrostatics
Filip Francqui,
GranuTools

086 *USA* 10:20 a.m.
Metallographic Characterization of Porous Low-Alloy Steel Samples Manufactured Using Both Powder Metallurgy and Additive Manufacturing Techniques
Thomas F. Murphy, FAPMI,
Hoeganaes Corporation

Monday, June 24 TECHNICAL SESSIONS

POWDERMET TECHNICAL SESSIONS Monday Afternoon 3:00–4:15 p.m.

SESSION 04

Ferrous Materials and Properties II

Session Chairman:
Mark Dougan,
AMES S.A.

184 *Germany* 3:00 p.m.
The Support Effect and Its Impact on the Design of Complex-Shaped Sintered PM Parts
Markus Schneider,
GKN Sinter Metals

014 *USA* 3:25 p.m.
The Effect of Laser Engraving on the Mechanical Behavior of Powder Metallurgy Components
Katrina S. Johnston,
Drexel University

096 *USA* 3:50 p.m.
Production Experience with Enhanced Ferro-Phosphorus Material Showing Reduced Tool Wear
Alex Wartenberg,
Hoeganaes Corporation

SESSION 05

Atomization II

Session Chairman:
Arun Chattopadhyay,
Uniformity Labs

035 *Canada* 3:00 p.m.
Demystifying the Mechanisms of Liquid Metal Disintegration: a 3D CFD Analysis of Water Droplet Impingement on Melt Stream
Cheng-Tse Wu,
University of Toronto

166 *USA* 3:25 p.m.
In Situ Gas-Phased Passivation of Low-Pressure Gas-Atomized Calcium Powder
Charles Czahor,
Iowa State University/Ames Laboratory

170 *USA* 3:50 p.m.
The Effect of Pour Tube Tip Extension on Close-Coupled Gas Atomization Die Flow
David J. Byrd,
Ames Laboratory (USDOE)

MANAGEMENT SESSION

Management Economic Indicators

Session Chairman:
John von Arx,
Phoenix Sintered Metals LLC

USA 3:00 p.m.
PM Industry Trends: Management Economic Indicators
All MPIF members receive the "Monthly Economic Indicators & Industry Trends," but how can they maximize this benefit? This presentation will focus on select indicators that have a major impact on the PM industry.
Paul Sedor,
Metal Powder Industries Federation

(No printed manuscript)



AMPM TECHNICAL SESSIONS Monday Afternoon 3:00–4:15 p.m.

SESSION A04

Nickel Alloys I

Session Chairman:
Ankit Saharan,
EOS Finland

141 *USA* 3:00 p.m.
Application of Directed Metal Deposition (DMD) for Manufacturing and Remanufacturing of Nickel Alloy Components
Arshad Harooni,
DM3D Technology

117 *USA* 3:25 p.m.
Properties and Microstructure of Inconel 625 Processed by Laser Powder Bed Fusion
Sundar V. Atre,
University of Louisville

110 *Australia* 3:50 p.m.
Effects of Powder Characteristics on Building Quality of Selective Laser Melting of Hastelloy X
Yang Tian,
Monash University

SESSION A05

Solid-State Processing

Session Chairman:
James W. Sears,
Carpenter Technology Corporation

081 *USA* 3:00 p.m.
Fatigue Study of 316L Produced Using Binder Jet 3D Printing with Hot Isostatic Pressing
Andrew Klein,
ExOne

077 *Canada* 3:25 p.m.
Additive Manufacturing of Soft and Hard Magnetic Materials Used in Electrical Machines
Fabrice Bernier,
National Research Council Canada

173 *USA* 3:50 p.m.
High-Performance 3D Printed Stainless Steel: A Metallurgical Perspective on 3DEO's Intelligent Layering
Mahmood Shirooyeh,
3DEO

SESSION A06

Modeling of Metal AM I

Session Chairman:
Emma White,
Ames Laboratory

078 *Finland* 3:00 p.m.
Process-Structure-Properties Modeling of Selective Laser Melted Maraging Steel Using Phase-Field Method and Crystal Plasticity
Tatu Pinomaa,
VTT

123 *USA* 3:25 p.m.
Marangoni Convection in Selective Laser Melting of 316L Stainless Steel
Prakash Gautam,
Montana Technological University

054 *USA* 3:50 p.m.
Using Computer Vision and Machine Learning to Create Super-Powder Fingerprints which Associate Powder Characteristics with Flow Properties in AM
Srujana Rao,
Carnegie Mellon University

Monday, June 24 TECHNICAL SESSIONS

MANAGEMENT SESSION—
Implementing a Cultural Change: The Development of a High-Performance Organization

Session Chairman:
Jeffrey Danaher, Sr., Abbott Furnace Company

4:30–5:45 p.m.

Why are some organizations more successful than others? One of the most recognizable reasons, but also most difficult to define, is the culture of the organization. Measurements of success in a manufacturing facility include:

- Satisfied customers
- Profitability
- Excellent material utilization
- On-time deliveries
- Low absenteeism and turnover rate
- Happy employees

But how do organizations score highly on all of these metrics? For most successful organizations, the answer was a change in culture. This presentation will define a dramatic change in culture, clear vision, and plan based on a case study of a powder metallurgy parts manufacturing facility. It will outline organizational culture, the change process, and difficulties that can be expected. It will provide benchmarks for a high-performance organization, barriers to implementation, comprehensive strategic planning, and sustainable successes.

Speaker: Gary L. Ramsey, Consultant

(No printed manuscript)

CPMT PRESENTATIONS—
Evaluation of Acoustical Mixing and Rust Prevention of PM Ferrous Parts

Session Chairman:
Thomas Pfingstler, Atlas Pressed Metals

4:30–5:20 p.m.

The Center for Powder Metallurgy Technology (CPMT) merges the academic and corporate PM worlds together with a joint goal to promote PM industry progress. Through collaboration, the transfer of knowledge and technology advancement is utilized to advance the growth of the PM industry.

This oral presentation-only session will share recent R&D activities completed by CPMT.

Evaluation of Acoustical Mixing
4:30–4:55 p.m.
John Engquist, FAPMI, JENS Solutions Inc.

CPMT conducted a project to evaluate the acoustical mixing of an FC-0208 to determine the effects on powder characteristics and sintered properties. The acoustical mixing process was compared to a baseline mix prepared using a standard, commercial double cone blender. This presentation will review the results of the investigation.

Rust Prevention of PM Ferrous Parts
4:55–5:20 p.m.
Kenneth Schatz, Metco Industries, Inc.

CPMT has an ongoing project to evaluate the effectiveness of known rust preventative fluids applied to various PM ferrous-based materials. The rust preventatives are used to extend the shelf-life of the PM components. This presentation will provide the test results and introduce discussion of a new guideline for humidity testing.

PM TECHNOLOGY SCAN 2019—
Improvement in Precision/ Accuracy/Variation Control

Session Chairman:
Blaine Stebick, Phoenix Sintered Metals LLC

5:20–5:45 p.m.

This presentation will focus upon recent technology developments, opportunities, perceived threats, challenges, and barriers to growth uncovered during the most recent Technology Assessment investigation performed by MPIF Technical Board members.

(Open only to qualified MPIF-member registrants)

Benefits of Precision/Accuracy/Variation Control
Powder metallurgy is an advanced metalworking technology, but as an industry, are we underestimating or limiting the growth of the industry by accepting the current state of the technology? Will improved process control dramatically affect the quality and cost of existing components or open new opportunities because of reduced secondary operations? This presentation is intended to stimulate discussion regarding the potential benefits of improving precision, accuracy, and variation control of PM components.

Speaker:
John Engquist, FAPMI, JENS Solutions Inc.

Investigators:
John Engquist, FAPMI, JENS Solutions Inc.
Roger Lawcock, FAPMI, Stackpole International
Bruce Lindsley, Hoeganaes Corporation
Roland Warzel, North American Höganäs Co.

(No printed manuscript)


AMPM TECHNICAL SESSIONS Monday Afternoon 4:30–5:45 p.m.

SESSION A07

Nickel Alloys II

Session Chairman:
Ravi Enneti,
Global Tungsten & Powders Corporation

127 *USA* 4:30 p.m.
Influence of Alloy 718 Powder Size on Density, Microstructure, Mechanical Properties, and Production Costs in Metal AM
Ronald Aman,
Carpenter Technology Corporation

094 *United Kingdom* 4:55 p.m.
Impact of Parameter Choice on Microstructure and Properties of Inconel Nickel Super-Alloy
G.A. Ravi,
Renishaw Inc.

136 *Finland* 5:20 p.m.
Micromechanical Modeling-Based Damage Laws for Fatigue Design of Additively Manufactured IN718 Alloy
Anssi Laukkanen,
VTT

SESSION A08

Exploratory Metal Powder Production

Session Chairman:
Joseph T. Strauss, FAPMI,
HJE Company, Inc.

017 *USA* 4:30 p.m.
Progress Towards Expeditionary Production of AM-Grade Metallic Powder
Marc S. Pepi,
U.S. Army Research Laboratory

108 *USA* 4:55 p.m.
Development of Deployable Systems for Point-of-Need Recycling and Additive Manufacturing
Andrew LaTour,
MolyWorks Materials Corporation

105 *USA* 5:20 p.m.
Melt-Free Continuous Titanium Alloy Powder: Production Facility and Development Center
Art Kracke,
AAK Consulting LLC

SESSION A09

Modeling of Metal AM II

Session Chairman:
Sudarsanam S. Babu,
University of Tennessee College of Engineering

076 *USA* 4:30 p.m.
Machine Learning-Enabled Molecular Dynamics Simulation of Laser Powder Bed Fusion Additive Manufacturing of Inconel718
Lingbin Meng,
Indiana University—Purdue University Indianapolis (IUPUI)

087 *USA* 4:55 p.m.
Microstructure Prediction of Laser Powder Bed Fusion Processed Metal Using Combined Computational Fluid Dynamics and Cellular Automata Methods
Jing Zhang,
Indiana University—Purdue University Indianapolis (IUPUI)

146 *USA* 5:20 p.m.
CFD Modeling in Laser Powder Bed Fusion, Selective Electron Beam Melting and Direct Energy Deposition Processes
Pareekshith Allu,
Flow Science, Inc.

Tuesday, June 25 TECHNICAL SESSIONS

POWDERMET TECHNICAL SESSIONS Tuesday Morning 8:00–9:15 a.m.

SESSION 06

Ferrous Materials and Properties III

Session Chairman:
Julie Campbell-Tremblay, PMT,
Rio Tinto Metal Powders

083 *USA* 8:00 a.m.
Manufacturing Methods for High-Density Powdered Metal (PM) Applications and Their Effect on Mechanical Properties
Amber Tims, PMT,
North American Höganäs Co.

168 *Canada* 8:25 a.m.
Optimization of Liquid-Phase Sintering of Boron PM Steels Using Master Alloys
Simon Gelinas,
Université Laval

183 *USA* 8:50 a.m.
A Method to Estimate Fatigue Axial Properties for Ferrous Powder Metal Materials
Virgiliu A. Savu,
GKN Sinter Metals

SESSION 07

MIM I

Session Chairman:
Michael Wiseman,
ARC Group Worldwide

057 *USA* 8:00 a.m.
Simulation and Experimental Verification of Two Cavity Balance in Injection Molding
Neal S. Myers,
Kennametal, Inc.

016 *USA* 8:25 a.m.
5 Reasons to Celebrate Mold Cleaning in Power Injection Molding
Steve Wilson,
Cold Jet LLC

200 *United Kindgom* 8:50 a.m.
Developments in High-Temperature Nickel Alloys for MIM Applications
Martin A. Kearns,
Sandvik Osprey Limited

SESSION 08

Non-Traditional Alloy Sintering

Session Chairman:
Raymond Serafini, PMT,
Linde, LLC

068 *USA* 8:00 a.m.
Commercial Sintering of Chromium Powder Metallurgy (PM) Steels
Roland T. Warzel III,
North American Höganäs Co.

135 *USA* 8:25 a.m.
Effects of Sintering Conditions on the Diffusion Bonding of AgC-Cu Electrical Contacts
Daudi R. Waryoba,
The Pennsylvania State University

187 *USA* 8:50 a.m.
High-Strength Aluminum-Zinc Composite PM Grade with Trace Amount of Copper for Powder Metallurgy Applications
Jessu Joys,
United States Metal Powders, Inc.

SPECIAL INTEREST PROGRAM — Tuesday Morning — 8:00–9:15 a.m.

SIP 2-1

Powder Production for AM, PM, MIM: Differences, Similarities and Synergies

Program Organizers:
Carl Blais, Laval University
Gilles L'Esperance, FAPMI, Ecole Polytechnique de Montreal

The emergence of metal additive manufacturing (AM) and its numerous technologies has created a demand for metal powders with specific characteristics such as particle size distribution, particle morphology, chemical composition, and cost. These requirements are not exactly new and other processes relying on metal powders, such as conventional powder metallurgy (PM) and metal injection molding (MIM), have similar requirements. Presentations will include insightful analyses of metal powders manufactured by different techniques utilized by the PM, MIM and AM industry.

Session Chairman: Denis Christopherson, Federal-Mogul Sintered Products

192 *USA* 8:00 a.m.
Improved Production Methods for Powders Used in Additive Manufacturing
Christopher Schade, Hoeganaes Corporation

193 *USA* 8:25 a.m.
The Effect of Production Process Route on Metal Powder Properties
Roland T. Warzel, III, North American Höganäs Co.

194 *Canada* 8:50 a.m.
Water-Atomized Metal Powders for PM, AM and MIM: Improvements and Potential Markets
Chantal Labrecque, Rio Tinto Metal Powders

AMPM TECHNICAL SESSIONS — Tuesday Morning — 8:00–9:15 a.m.

SESSION A10

Aluminum Alloys

Session Chairman:
S.K. Tam, ORMCO

153 *Finland* 8:00 a.m.
High-Performance Aluminum Alloys by Additive Manufacturing
Juha Kotila, EOS Finland

069 *USA* 8:25 a.m.
Investigation of the Selective Laser Melting Process for AlSi10Mg and AA6061 Fabricated at High Laser Power
Michael V. Pires, Lehigh University

041 *USA* 8:50 a.m.
Nanofunctionalized Metal Powders for Additive Manufacturing of Crack-Free High-Strength Aluminum Alloys
John H. Martin, HRL Laboratories LLC

SESSION A11

NDT Methods Applied to AM Powders and Components

Session Chairman:
Michael Stucky, Norwood Injection Technologies

085 *Canada* 8:00 a.m.
Quantification of Contaminants in 3D Printing Metal Powders Using Micro-focus X-Ray Tomography
Roger Pelletier, National Research Council Canada

120 *USA* 8:25 a.m.
Assessing Post-Processing States of AM Builds with Analysis of Ultrasonic Dispersion Properties
Ajay V. Krishnan, Incodema3D, LLC

131 *USA* 8:50 a.m.
NDT of Metal Additively Manufactured Parts via Acoustic Resonance Testing
Bryan Butsch, The Modal Shop, Inc.

SESSION A12

Metal AM: Processes and Applications

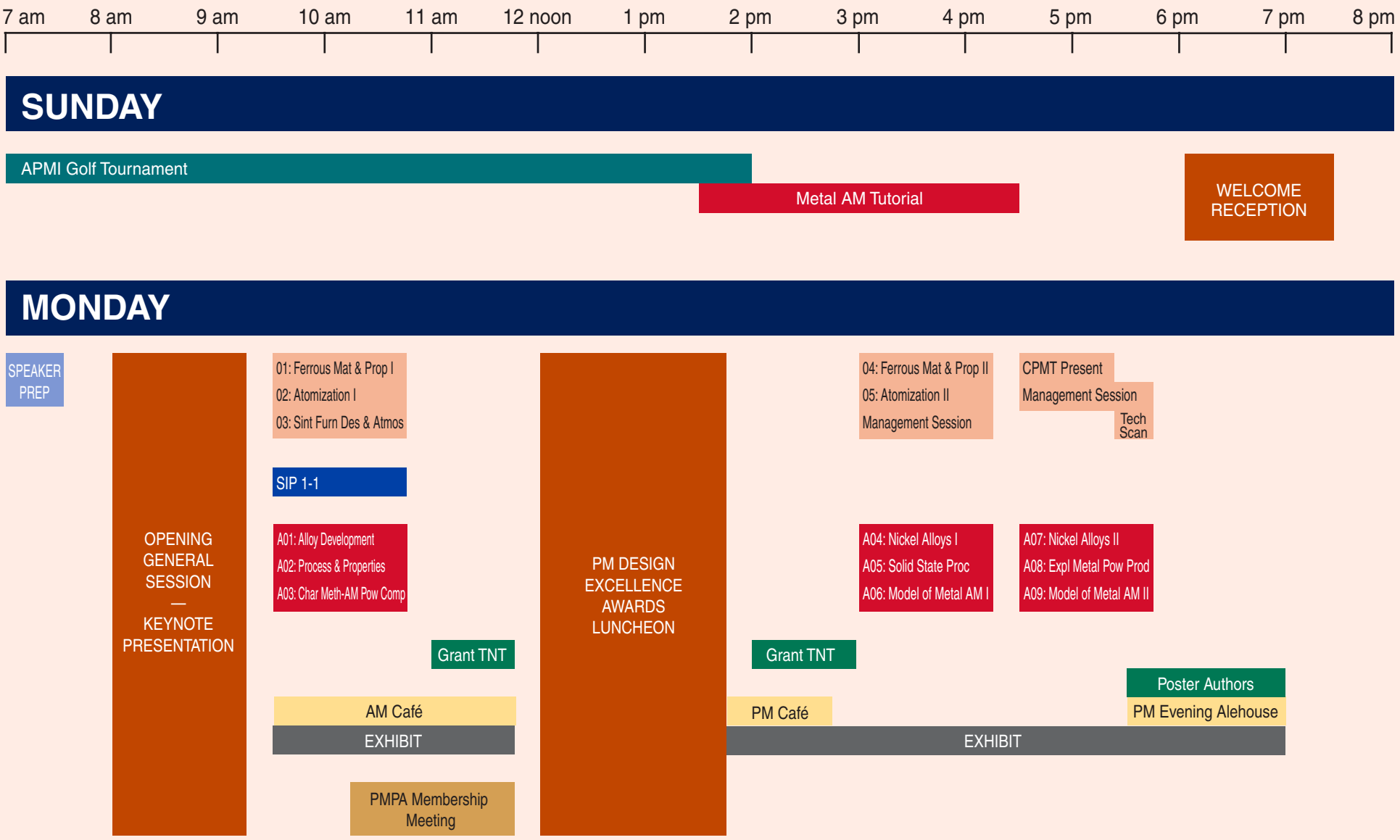
Session Chairman:
Hyrum Lefler, Carpenter Technology Corporation

137 *USA* 8:00 a.m.
Manufacturing, Remanufacturing and Reconfiguration of Aerospace Components with Direct Metal Deposition (DMD)
Arshad Harooni, DM3D Technology

067 *USA* 8:25 a.m.
Fused-Filament Fabrication of Metal with a Markforged Metal X System
Michelle Chao, Markforged

161 *Germany* 8:50 a.m.
3D Screen Printing of Metal Powder
Guido Stiebritz, H.C. Starck Hermsdorf GmbH

Schedule-at-a-Glance



TUESDAY

SPEAKER PREP

06: Ferrous Mat & Prop III
07: MIM I
08: Non-Trad Alloy Sinter

SIP 2-1

A10: Aluminum Alloys
A11: NDT Meth App AM Pow & Com
A12: Metal AM: Proc & Applications

09: Ferrous Mat & Prop IV
10: MIM II
11: Modeling I

SIP 2-2

A13: Biomedical Applic
A15: Recycl of AM Powd I
A15: Proc Enhanc & Monit

Grant TNT

AM Café

EXHIBIT

INDUSTRY LUNCHEON

12: Adv Part Materials
13: Novel Sintering
14: Modeling II

SIP 2-3

A16: Organic Binder Based AM
A17: Recycl of AM Powd II
A18: Eff of AM Proc Mech Prop

Grant TNT

PM Café

EXHIBIT

CLOSING EVENT

PMEA Membership Meeting

WEDNESDAY

SPEAKER PREP

15: Furn & HIP Tech
16: Refractory Matls
17: Densification

SIP 3-1

A19: Tribol & Corrosion
A20: Powd Char for AM
A21: Bind Jet of Met Pow

18: Material Processing
19: Comp Dev & Optim
20: PM Applications

SIP 3-2

A22: AM Pow Flow Char
A23: Des of Met AM Struct
A24: Copper-Based AM

21: PowdTest & Evalu
22: Secondary Operat
23: Safety & Mgmt

SIP 3-3

A25: Sintering of AM
A26: Met AM Post Proc

Conf. Committee

AMAM Membership Meeting

0700 hrs 0800 0900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000

Tuesday, June 25 TECHNICAL SESSIONS

POWDERMET TECHNICAL SESSIONS Tuesday Morning 10:30–11:45 a.m.

SESSION 09

Ferrous Materials and Properties IV

Session Chairman:
Amber Tims, PMT,
North American Höganäs Co.

097 *USA* 10:30 a.m.
Advanced Material Options for High-Temperature Sintering
Kylan McQuaig,
Hoeganaes Corporation

028 *Canada* 10:55 a.m.
The Effect of Sintering Temperature on the As-Sintered and Heat Treated Properties of Pre-Alloyed Mo Low-Carbon Steel Alloyed with Ferromanganese
Peng Shen,
Stackpole International

130 *USA* 11:20 a.m.
Fatigue and Fracture Behavior of Solid- and Liquid-Phase Sintered Fe PM Samples with C, Ni and Cu Additions and Comparisons with Fatigue and Fracture Behavior of AM Coupons
Vibhor Chaswal,
The Pennsylvania State University, DuBois

SESSION 10

MIM II

Session Chairman:
Stefan Joens,
Elnik Systems, LLC

177 *USA* 10:30 a.m.
Properties and Dimensional Performance of Pre-Alloy and Master Alloy Powders on Stainless Steel Metal Injection Molded Parts
James A. Sago,
MPP

055 *USA* 10:55 a.m.
The Effects of Sintering Temperature on the Microstructural Evolution of 718
Rees Jones,
ARC Group Worldwide

138 *USA* 11:20 a.m.
Optimizing Extrusion Process Using Water Atomized 17-4 Stainless Steel Powders
Jian Zhang,
Indiana University—Purdue University Indianapolis (IUPUI)

SESSION 11

Modeling I

Session Chairman:
Nicholas Hunt,
Catalus Corporation

063 *USA* 10:30 a.m.
Numerical Simulation of Close-Coupled Gas Atomization: Impact of Geometric and Fluid Parameters
Franz Hernandez,
Ames Laboratory (USDOE)

165 *USA* 10:55 a.m.
Powder Flow in Additive Manufacturing—Challenges and Opportunities
Andres D. Orlando,
Jenike & Johanson, Inc.

031 *USA* 11:20 a.m.
Importance of Particle-Size Distribution and Thermal Stress Factors—A Theoretical Approach to Predict Defects in AM Parts
Arun K. Chattopadhyay,
Uniformity Labs

SPECIAL INTEREST PROGRAM Tuesday Morning 10:30–11:45 a.m.

SIP 2-2

Powder Production for AM, PM, MIM: Moving Away from Two-Fluid Atomization

Program Organizers:
Carl Blais, Laval University
Gilles L'Esperance, FAPMI, Ecole Polytechnique de Montreal

The emergence of metal additive manufacturing (AM) and its numerous technologies has created a demand for metal powders with specific characteristics such as particle size distribution, particle morphology, chemical composition, and cost. These requirements are not exactly new and other processes relying on metal powders, such as conventional powder metallurgy (PM) and metal injection molding (MIM), have similar requirements. Presentations will include insightful analyses of metal powders manufactured by different techniques utilized by the PM, MIM and AM industry.

Session Chairman: Gilles L'Esperance, FAPMI, Ecole Polytechnique de Montreal

195 *Canada* 10:30 a.m.
Powder Production and Characterization Methods for AM
Jérôme Pollak,
Tekna Advanced Materials, Inc.

196 *Canada* 10:55 a.m.
Solving AM Challenges with Plasma Atomization
Frédéric Marion,
AP&C

197 *Canada* 11:20 a.m.
Description of Various Additive Manufacturing Applications Made with Powders Produced with a Proprietary Atomizing Technology
Amir Nobari,
5N Plus Micro Powders

AMPM TECHNICAL SESSIONS Tuesday Morning 10:30–11:45 a.m.

SESSION A13

Biomedical Applications

Session Chairman:
Katie Jo Sunday,
Hoeganaes Corporation

040 *United Kingdom* 10:30 a.m.
Alloys-by-Design: a Biomedical Titanium Alloy for Additive Manufacturing
Enrique Alabort,
OxMet Technologies

072 *Finland* 10:55 a.m.
Increasing Fatigue Life of Additively Manufactured CoCrMo Alloy with Affordable Heat Treatment
Riku Ruohomaa,
EOS Finland

098 *USA* 11:20 a.m.
3D Printing of Biomimetically Inspired Zircon for Ceramic Mold Components
Tejesh C. Dube,
Indiana University—Purdue University Indianapolis (IUPUI)

SESSION A14

Recycling of AM Powders I

Session Chairman:
Alan Taylor,
GKN Sinter Metals

112 *USA* 10:30 a.m.
Powder Reconditioning of AM Feedstock to Increase Processing Efficiency
Timothy E. Prost,
Ames Laboratory

071 *USA* 10:55 a.m.
Recyclability of Ti-48Al-2Nb-2Cr Powder in Additive Manufacturing
Andrzej L. Wojcieszynski,
ATI Specialty Materials

201 *United Kingdom* 11:20 a.m.
Development of Enhanced Tool Steels for Powder Bed Fusion Additive Manufacturing
Martin A. Kearns,
Sandvik Osprey Limited

SESSION A15

Process Enhancement and Monitoring

Session Chairman:
Bhaskar Dutta,
DM3D Technology, LLC

095 *United Kingdom* 10:30 a.m.
Real-Time Process Monitoring Accelerates Process Development and Streamlines Process Control
Marc Saunders,
Renishaw Inc.

129 *USA* 10:55 a.m.
Improving Productivity in Laser Powder Bed Fusion Systems
James W. Sears,
Carpenter Technology Corporation

172 *USA* 11:20 a.m.
In-Process Monitoring for Laser Metal Deposition
Melanie A. Lang,
Formalloy

Tuesday, June 25 TECHNICAL SESSIONS

POWDERMET TECHNICAL SESSIONS Tuesday Afternoon 3:15–4:30 p.m.

SESSION 12
Advanced Particulate Materials
Session Chairman:
Bo Hu,
North American Höganäs Co.

061 *USA* 3:15 p.m.
Investigation of Powder Processing, Heat Treating, and Texturing to Improve Gas-Atomized Alnico Magnets for Use in Electric Drive Motors
Emily A. Rinko,
Iowa State University

132 *USA* 3:40 p.m.
Multistage Foaming of Powder Particles for Structural and Functional Applications
Samuel Brennan,
Millersville Univeristy

044 *USA* 4:05 p.m.
Results of Experiments with Cold Spray Deposition of Fe-Based ODS Alloys Using As-Atomized Spherical GARS Powder
Rebecca Whitesell,
Iowa State University

SESSION 13
Novel Sintering
Session Chairman:
Robert Dowding,
U.S. Army Research Laboratory

104 *USA* 3:15 p.m.
Microgravity Liquid-Phase Sintering
Randall M. German, FAPMI,
German Materials Technology

156 *USA* 3:40 p.m.
Spark Plasma Sintering of Tungsten and Lanthanated Tungsten
John L. Johnson, FAPMI,
Elmet Technologies LLC

049 *USA* 4:05 p.m.
Manipulating Bimodal Grain-Size Distribution to Enhance Material Properties in a Spark Plasma Sintered Nanostructured FeNiZr Alloy
Sean Fudger,
U.S. Army Research Laboratory

SESSION 14
Modeling II
Session Chairman:
George Coppens,
Means Industries

148 *Italy* 3:15 p.m.
The Analysis of the Densification Curve of Metallic Powders in Uniaxial Cold Compaction
Ilaria Cristofolini,
University of Trento

149 *Italy* 3:40 p.m.
A Design Procedure to Define the Optimum Hardness of Parts Subject to Contact Stresses
Alberto Molinari, FAPMI,
University of Trento

090 *USA* 4:05 p.m.
Modeling of Plasma Spray Process for Thermal Barrier Coating
Abhilash Gulhane,
Indiana University—Purdue University Indianapolis (IUPUI)

SPECIAL INTEREST PROGRAM Tuesday Afternoon 3:15–4:30 p.m.

SIP 2-3

Powder Production for AM, PM, MIM: Process Characterization, Parameters and Design

Program Organizers:
Carl Blais, Laval University
Gilles L'Esperance, FAPMI, Ecole Polytechnique de Montreal

The emergence of metal additive manufacturing (AM) and its numerous technologies has created a demand for metal powders with specific characteristics such as particle size distribution, particle morphology, chemical composition, and cost. These requirements are not exactly new and other processes relying on metal powders, such as conventional powder metallurgy (PM) and metal injection molding (MIM), have similar requirements. Presentations will include insightful analyses of metal powders manufactured by different techniques utilized by the PM, MIM, and AM industry.

Session Chairman: Carl Blais, Laval University

198 *USA* 3:15 p.m.
Process Influence on Non-Ferrous Metal Powders
Thomas W. Pelletiers,
Kymera International

199 *USA* 3:40 p.m.
Industrial Gas Atomization for Additive Manufacturing and Beyond
John Meyer,
Carpenter Technology Corporation

062 *USA* 4:05 p.m.
Development of Effective Tools for Precise Selection of Atomization Parameters to Optimize Powder Production
Jordan A. Tiarks,
Ames Laboratory (USDOE)

AMPM TECHNICAL SESSIONS Tuesday Afternoon 3:15–4:30 p.m.

SESSION A16

Organic Binder-Based AM

Session Chairman:
Thomas F. Murphy, FAPMI,
Hoeganaes Corporation

032 *USA* 3:15 p.m.
Additive Manufacturing of a Novel Cr-Ni Alloy Using the Bound Metal Deposition (BMD) Technique
Animesh Bose, FAPMI,
Desktop Metal, Inc.

151 *USA* 3:40 p.m.
3D Printing and Sintering of Bronze Filament
Jing Zhang,
Indiana University—Purdue University Indianapolis (IUPUI)

134 *USA* 4:05 p.m.
Structure-Property Relationships in WC-12Co Made by Binder Jetting Additive Manufacturing
Zhuqing Wang,
Kennametal

SESSION A17

Recycling of AM Powders II

Session Chairman:
Deepak Madan,
Luxfer Magtech

093 *United Kingdom* 3:15 p.m.
Powder Re-Use Strategies for Additive Manufacturing Production
Lucy Grainger,
Renishaw Inc.

121 *USA* 3:40 p.m.
Effect of Powder Reuse on Static Mechanical Properties of Stainless Steels Produced Through Selective Laser Melting
Jessica Schiltz,
University of Notre Dame

073 *USA* 4:05 p.m.
The Effect of the Number of Printer Cycles on Titanium & Steel Powders Used for AM
Tony Thornton,
Micromeritics Instrument Corporation

SESSION A18

Effect of AM Process on Mechanical Properties

Session Chairman:
Jane LaGoy

162 *USA* 3:15 p.m.
Robust Metal Additive Manufacturing Development and Industrialization
Youping Gao,
Castheon, Inc.

091 *USA* 3:40 p.m.
Influence of Powder Manufacturing Process on Properties of Laser-Powder Bed Fusion Processed Ti-6Al-4V
Kunal Kate,
University of Louisville

046 *USA* 4:05 p.m.
3D Printed Steel Tooling and Dies for High-Volume Part Production
Jonathan Trenkle,
Formetrix

Wednesday, June 26 TECHNICAL SESSIONS

POWDERMET TECHNICAL SESSIONS Wednesday Morning 8:00–9:15 a.m.

SESSION 15

Furnace and HIP Technology

Session Chairman:
Jason Ting,
Thermal Technology LLC

144 *USA* 8:00 a.m.
Introduction to Furnace Technology as It Relates to Various Powdered Metal Applications
Michael Hager,
Verder Scientific, Inc

065 *Australia* 8:25 a.m.
The Evolution of Hot Isostatic Pressing for the Treatment of Radioactive Wastes
Salvatore (Sam) Moricca,
AMEPT LLC

079-R *USA* 8:50 a.m.
The Influence of Hot Isostatic Pressing (HIP) and Heat Treatment on the Microstructure and Properties of PBF IN718
Magnus Ahlfors,
Quintus Technologies

SESSION 16

Refractory Materials

Session Chairman:
Pankaj Trivedi,
Kennametal Inc.

082 *USA* 8:00 a.m.
Additive Manufacturing of Polymer Derived Ceramics
Xuehui Yang,
Indiana University—Purdue University Indianapolis (IUPUI)

066 *Germany* 8:25 a.m.
On the Metallurgy and Manufacture of Cast Metallic Heat Resistant Alloys as Components for Powder Processing Applications
Shankar Venkataraman,
Schmidt + Clemens Group

118 *Germany* 8:50 a.m.
NbC-TiC7N3 Cermets for Machining and for Wear Protection
Mathias Woydt,
BAM Federal Institute for Materials and Testing

SESSION 17

Densification

Session Chairman:
Dustin Yetzer,
Abbott Furnace Company

013 *Canada* 8:00 a.m.
For Powder Bed Additive Manufacturing Process: Correlations Between Single Layer Density and Powder Properties with the Assistance of Coherence Scanning Interferometry
Basel Alchikh-Sulaiman,
McGill University

075 *USA* 8:25 a.m.
The Influence of Precursor Derived Secondary Structures on the Sintering Behavior of Binder Jet 3D Printed Titanium Dioxide
Lynnora Grant,
Rice University

145 *USA* 8:50 a.m.
Loose Powder Sintering: An Overview of Densification Behavior Pore Formation of Copper and 435 Steel Powders
Arun K. Chattopadhyay,
Uniformity Labs

SPECIAL INTEREST PROGRAM — Wednesday Morning — 8:00–9:15 a.m.

SIP 3-1

Machinery Sensors and Information Technology: Industry Sensors I—I'm Looking for Data

Program Organizers:
Thomas W. Pelletiers, Kymera International
Blaine Stebick, Phoenix Sintered Metals LLC
Willam R. Gasbarre, FAPMI, Gasbarre Products, Inc.
Daniel P. Reardon, Abbott Furnace Company

The ability to control processes is directly related to monitoring the variables driving the process. In PM, temperature, velocity, flow, position, pressure, and force are all examples of data critical to the quality of product produced. Developments in sensors monitoring and controlling various processes in the PM industry are explored defining current state-of-the-art, emerging new technology, and the architecture used to deliver this data to enterprise wide information systems. Combining the data can enable real time decisions improving quality, efficiency, accuracy, and delivery.

Session Chairman: Thomas W. Pelletiers, Kymera International

181 *USA* 8:00 a.m.
Sensors Related to Sintering
Dustin Yetzer,
Abbott Furnace Company

026 *USA* 8:25 a.m.
Quality Monitoring in the Overall Manufacturing Process Using Acoustic Resonance
Bryan Butsch,
The Modal Shop, Inc.

189 *USA* 8:50 a.m.
3D Measurement and Inspection
Christopher Wirth,
Keyence

AMPM TECHNICAL SESSIONS — Wednesday Morning — 8:00–9:15 a.m.

SESSION A19

Tribology and Corrosion

Session Chairman:
Rajiv Tandon,
Luxfer Magtech

114 *USA* 8:00 a.m.
Corrosion Properties of Inconel 625 Processed by Laser Powder Bed Fusion
Sundar V. Atre,
University of Louisville

115 *USA* 8:25 a.m.
Advanced Corrosion Studies of Alloys Fabricated by Laser Powder Bed Fusion
Sundar V. Atre,
University of Louisville

036 *Slovenia* 8:50 a.m.
Anti-Wear Properties of Direct Metal Laser Sintered Steel Parts and the Effect of Printing Direction
Bojan Podgornik,
Institute of Metals and Technology

SESSION A20

Powder Characterization for AM

Session Chairman:
Andrzej Wojcieszynski,
ATI Powder Metals

007 *USA* 8:00 a.m.
Automated Particle Size and Shape Characterization of Metal Powders for Additive Manufacturing
Alan F. Rawle,
Malvern Panalytical

167 *USA* 8:25 a.m.
Effects of Powder Characteristics, Recycling, and Process Parameters on the Microstructural and Mechanical Properties of Direct Energy Deposition Ti-6Al-4V
Courtney B. Morgan,
Center for Advanced Vehicular Systems (CAVS)—Mississippi State University

140 *USA* 8:50 a.m.
SuperPowder: A Computer Vision Approach to Morphological Distribution Analysis for Metal Powders
Andrew R. Kitahara,
Carnegie Mellon University

SESSION A21

Binder Jetting of Metal Powder

Session Chairman:
Robert M. Gasior,
Arconic Technology Center

018 *USA* 8:00 a.m.
Dimensional Stability in Binder Jet 3D Direct Metal Printing
James W. Sears,
Carpenter Technology Corporation

081-R *USA* 8:25 a.m.
Fatigue Study of 316L Produced Using Binder Jet 3D Printing with Hot Isostatic Pressing
Andrew Klein,
ExOne

169 *USA* 8:50 a.m.
A Review of Additive Manufacturing Methods for Tungsten Heavy Alloy
Michael T. Stawovy,
H. C. Starck Inc.

Wednesday, June 26 TECHNICAL SESSIONS

POWDERMET TECHNICAL SESSIONS Wednesday Morning 9:30–10:45 a.m.

SESSION 18

Material Processing

Session Chairman:
Richard Walker,
Pressure Technology, Inc.

083-R *USA* 9:30 a.m.
Manufacturing Methods for High-Density Powdered Metal (PM) Applications and Their Effect on Mechanical Properties
Amber Tims,
North American Höganäs Co.

064 *Malaysia* 9:55 a.m.
A Preliminary Process for Incorporation of Graphene Reinforcement in Copper-Based Feedstock
Faiz Ahmad,
Universiti Teknologi PETRONAS (UTP)

135-R *USA* 10:20 a.m.
Effects of Sintering Conditions on the Diffusion Bonding of AgC-Cu Electrical Contacts
Daudi R. Waryoba,
The Pennsylvania State University

SESSION 19

Compacting Development and Optimization

Session Chairman:
Jerry Falleur, PMT,
AAM—Powertrain

126 *Switzerland* 9:30 a.m.
A Revolutionary Approach to Tooling Changeover on Multi-Level Presses
Guillermo Polo,
Osterwalder Inc.

005 *USA* 9:55 a.m.
Room Temperature Compaction for Higher Density in Powder Metal Parts,+325 Compaction
Kalathur S. Narasimhan, FAPMI,
P2P Technologies

171 *Germany* 10:20 a.m.
Modern Automation Systems for Powder Compaction Presses
Nicolas Hemmer,
KOMAGE Gellner Maschinenfabrik KG

SESSION 20

PM Applications

Session Chairman:
Robert Hayes,
Phoenix Sintered Metals LLC

124 *Spain* 9:30 a.m.
Methods for the Reduction of the Friction Coefficient of Sintered Bushings
Mark J. Dougan,
AMES PM Tech Center

176 *USA* 9:55 a.m.
Wear Resistance and Mechanical Properties of PM Alloy Materials
Arthur E. Jones,
Symmco Inc.

187-R *USA* 10:20 a.m.
High-Strength Aluminum-Zinc Composite PM Grade with Trace Amount of Copper for Powder Metallurgy Applications
Jessu Joys,
United States Metal Powders, Inc.

SPECIAL INTEREST PROGRAM Wednesday Morning 9:30–10:45 a.m.

SIP 3-2

Machinery Sensors and Information Technology: Industry Sensors II—Let's Organize the Data

Program Organizers:

Thomas W. Pelletiers, Kymera International

Blaine Stebick, Phoenix Sintered Metals LLC

Willam R. Gasbarre, FAPMI, Gasbarre Products, Inc.

Daniel P. Reardon, Abbott Furnace Company

The ability to control processes is directly related to monitoring the variables driving the process. In PM, temperature, velocity, flow, position, pressure, and force are all examples of data critical to the quality of product produced. Developments in sensors monitoring and controlling various processes in the PM industry are explored defining current state-of-the-art, emerging new technology, and the architecture used to deliver this data to enterprise wide information systems. Combining the data can enable real time decisions improving quality, efficiency, accuracy, and delivery.

Session Chairman: William R. Gasbarre, FAPMI, Gasbarre Products, Inc.

180 *USA* 9:30 a.m.
Overview of Industrial Data Collection Systems
Larry Shindledecker,
Gasbarre Products, Inc.

179 *USA* 9:55 a.m.
I Have Data! Now What?
Jeffrey F. Chileski,
Abbott Furnace Company

190 *USA* 10:20 a.m.
Smart Sensors
J.J. Thiara,
Rockwell Automation

AMPM TECHNICAL SESSIONS Wednesday Morning 9:30–10:45 a.m.

SESSION A22

AM Powder Flow Characterization

Session Chairman:
Chaman Lall,
MPP

100 *Canada* 9:30 a.m.
Understanding the Factors Influencing Powder Spreadability for Laser Powder Bed Fusion
Eileen Ross L. Espiritu,
McGill University

060 *Canada* 9:55 a.m.
Powder Flowability and Density: Effect of Humidity and Impact on the Reproducibility of the Measurements
Louis-Philippe Lefebvre,
National Research Council Canada

033 *Canada* 10:20 a.m.
Correlation Between the Flowability of Ti-6Al-4V Powders Used in the Laser Powder Bed Fusion Process and the Process Performances
Salah Eddine Brika,
Université du Québec

SESSION A23

Design of Metal AM Structures

Session Chairman:
Howard Kuhn,
University of Pittsburgh

029 *United Kingdom* 9:30 a.m.
Multifunctional Lattices by Additive Manufacturing
Daniel Barba,
University of Oxford

020 *United Kingdom* 9:55 a.m.
Application of Lattice Structures for Convective Heat Transfer
Sam Catchpole-Smith,
University of Nottingham

102 *Spain* 10:20 a.m.
On the Size-Dependent Strength of Additive Manufactured Titanium
Carles Alabort,
Polytechnic University of Valencia

SESSION A24

Copper-Based AM

Session Chairman:
Richard Mason,
Mason Global Materials

089 *USA* 9:30 a.m.
Effect of Solids Loading, and Volumetric Flow Rate on Properties of Metal-Fused Filament Fabricated (MF3) Bronze
Paramjot Singh,
University of Louisville

178 *Germany* 9:55 a.m.
Raising Copper Parts in Size-Enabling Advanced Space Applications
Martin Bullemer,
AMCM GmbH

10:20 a.m.
No presentation scheduled at this time.

Wednesday, June 26 TECHNICAL SESSIONS

POWDERMET TECHNICAL SESSIONS Wednesday Morning 11:00 a.m.–12:15 p.m.

SESSION 21

Powder Test and Evaluation

Session Chairman:
Jessu Joys,
United States Metal Powders, Inc.

038 *USA* 11:00 a.m.
3D Digital Image Correlation: The Ultimate Tool for Displacements and Strains Testing
Charles-Olivier Amyot,
Trilion Quality Systems

043 *Canada* 11:25 a.m.
Powder Properties Characterization of PM Lubricants Using FT4 Powder Rheometer
Jean V. Reid,
H.L. Blachford Ltd.

023 *Canada* 11:50 a.m.
Using Powder Rheology Measurements to Optimize the Mixing Time of an Iron-Based Premix for Best Die-Filling Performance
Boris Nijikovsky,
Université du Québec

SESSION 22

Secondary Operations

Session Chairman:
John Lyons, III,
Line Craft, Inc.

030 *USA* 11:00 a.m.
Effect of Hybrid Post-Sinter Treatment on Sinter Hardened (SH) Structural Parts from PM Steels
Leonid I. Frayman,
Allegheny Coatings/Pamlico Coatings Group

070 *USA* 11:25 a.m.
Effect of Carbon Content on the Machinability of Powdered Metal Copper Steels
Cody Kalinoski,
Engineered Sintered Components

012 *USA* 11:50 a.m.
Study on Corrosion Performance and Microstructure of Sinter Hardened Artifacts Subjected to Various Finishing
Leonid I. Frayman,
Allegheny Coatings/Pamlico Coatings Group

SESSION 23

Safety and Management

Session Chairman:
Arthur E. Jones,
Symmco, Inc.

139 *USA* 11:00 a.m.
Contaminated Cartridge-Type Dust Collectors May Pose Serious Health and Environmental Risks
Michael W. Seitz,
BlueSky Global

150 *Canada* 11:25 a.m.
Metal Powder Recycling—Closing the Loop on Sustainability
Josh Lifshitz,
Globe Metal

175 *USA* 11:50 a.m.
Talent Acquisition, Utilization and Retention in the PM Industry... It's Time to End the Recycle
Rocco Petrilli,
PKPM Advisory Group

SPECIAL INTEREST PROGRAM Wednesday Morning 11:00 a.m.–12:15 p.m.

SIP 3-3

Machinery Sensors and Information Technology: Industry Sensors III—Impacting Business Operations with My Data

Program Organizers:

Thomas W. Pelletiers, Kymera International

Blaine Stebick, Phoenix Sintered Metals LLC

Willam R. Gasbarre, FAPMI, Gasbarre Products, Inc.

Daniel P. Reardon, Abbott Furnace Company

The ability to control processes is directly related to monitoring the variables driving the process. In PM, temperature, velocity, flow, position, pressure, and force are all examples of data critical to the quality of product produced. Developments in sensors monitoring and controlling various processes in the PM industry are explored defining current state-of-the-art, emerging new technology, and the architecture used to deliver this data to enterprise wide information systems. Combining the data can enable real time decisions improving quality, efficiency, accuracy, and delivery.

Session Chairman: Daniel P. Reardon, Abbott Furnace Company

188 *USA* 11:00 a.m.
A Platform for Data Science Applications to Industrial Processes—Part I
Dilsat Dalkiran,
SAP America

202 *USA* 11:25 a.m.
A Platform for Data Science Applications to Industrial Processes—Part II
Dilsat Dalkiran,
SAP America

205 USA 11:50 a.m.
Industry 4.0 and Big Data: The Signal and the Noise
Steven R. Schmid,
University of Notre Dame

AMPM TECHNICAL SESSIONS Wednesday Morning 11:00 a.m.–12:15 p.m.

SESSION A25

Sintering of AM Materials

Session Chairman:
Richard Huff,
GE Additive

034 *USA* 11:00 a.m.
Binder-Jet 3D Direct Metal Printing of Cobalt Chrome Moly Alloy
James W. Sears,
Carpenter Technology Corporation

056 *USA* 11:25 a.m.
Simulations of the Stress Field Around a Sinter-Crack
Reid Carazzone,
Rice University

037 *USA* 11:50 a.m.
Evaluation of AM Technologies in MIM Applications
Joseph T. Strauss, FAPMI,
HJE Company, Inc.

SESSION A26

Metal AM Post Processing

Session Chairman:
Chad Spore,
John Deere

107 *USA* 11:00 a.m.
Machining of Metal AM Parts in an Industry 4.0 Environment—Design, Process Control and Inspection Techniques
Dan Skulan,
Renishaw Inc.

079 *USA* 11:25 a.m.
The Influence of Hot Isostatic Pressing (HIP) and Heat Treatment on the Microstructure and Properties of PBF IN718
Magnus Ahlfors,
Quintus Technologies

109 *USA* 11:50 a.m.
Changing the Additive Manufacturing Industry with New, Efficient Furnace Technology
Janusz Kowalewski,
Ipsen

POSTER PROGRAM

INTERNATIONAL POSTERS dealing with various aspects of PM and particulate materials technologies will be displayed daily starting on Monday morning. Authors will be available at their posters for discussion Monday (5:30–7:00 p.m.) during the PM Evening Alehouse. Manuscripts submitted from poster authors will be published in the conference proceedings.

"Outstanding Poster" and "Poster of Merit" awards will be given by the Poster Awards Committee for displays that best meet the established criteria. Award ribbons will be posted prior to the designated discussion period on Monday.

Grant TNT: Talk 'N Technology also have dedicated times throughout the conference. See the Daily Schedule for details.

Additionally, 44 National Science Foundation Grant recipients and CPMT student posters will be on display.

POSTER COMMITTEE

Scott Davis, *Chairman*
Hoeganaes Corporation

John Blauser
Hoeganaes Corporation

Cynthia Freeby
Ametek Specialty Metal Products

Nicholas T. Mares, FAPMI

POSTER A: MATERIALS

009 *India*
Effect of Phosphorous Addition on Tribological Behavior of Copper Processed Through Powder Metallurgy
Leevan Rajendran, Vikram Sarabhai Space Centre

042 *Taiwan*
Thermoelectric Properties of Zn4Sb3 Prepared by Mechanical Alloying and Different Consolidation Routes
Pee-Yew Lee, National Taiwan Ocean University

101 *USA*
A Low-Cost, Industrial Scalable, Cleantech Method for Recycling Stainless Steel Machining Waste into 3D Printable Powders, Using High-Energy Milling Equipment
Steven R. Longpre, BSS Additive

159 *USA*
Improvement of Core Loss in Oriented Electrical Steels with Mn-Doped MgO Insulation Coating Layer
Bong Gu Kim, Indiana University—Purdue University Indianapolis (IUPUI)

POSTER B: PROCESSING

011 *USA*
Hybrid Post-Sinter Treatment of Sinter Hardened Artifacts from PM Steels
Andrew A. Serafini, The Pennsylvania State University—Dubois

025 *Taiwan*
Preparation of Highly Anisotropic NdFeB Powders and Enhancing Their Coercivity by the Dye-Free Grain Boundary Diffusion Process
Hung-Shang, Huang China Steel Corporation

039 *USA*
Influence of SLM Processing Parameters on Mechanical Properties of Tungsten-Heavy Alloys
Bartlomiej K. Bancewicz, Lehigh University

045 *USA*
Effect of Scanning Strategies on the Melt Pool Geometry During Powder Bed Fusion Additive Manufacturing
Antonio Magana-Ceballos, California State University—Los Angeles

050 *Canada*
A Novel Method for Determining the Packing Factor of Powder for Electron Beam Powder Bed Fusion Application
Basel Alchikh-Sulaiman, McGill University

128 *USA*
Electron Beam Physical Vapour Deposition Models for Thermal Barrier Coating Fabrications
Anvesh Dhulipalla, Indiana University—Purdue University Indianapolis (IUPUI)

155 *USA*
3D Printing of Biomimetic Inspired Zircon Ceramic Structures
Piyush P. Raikar, Indiana University—Purdue University Indianapolis (IUPUI)

POSTER C: PROPERTIES

152 *USA*
Creep Modeling of 3D Printed Inconel718
Harshal Dhamade, Indiana University—Purdue University Indianapolis (IUPUI)

154 *USA*
Thermal Fatigue Modeling of Thermal Barrier Coating
Abhilash Gulhane, Indiana University—Purdue University Indianapolis (IUPUI)

STUDENT GRANT POSTER PROGRAM

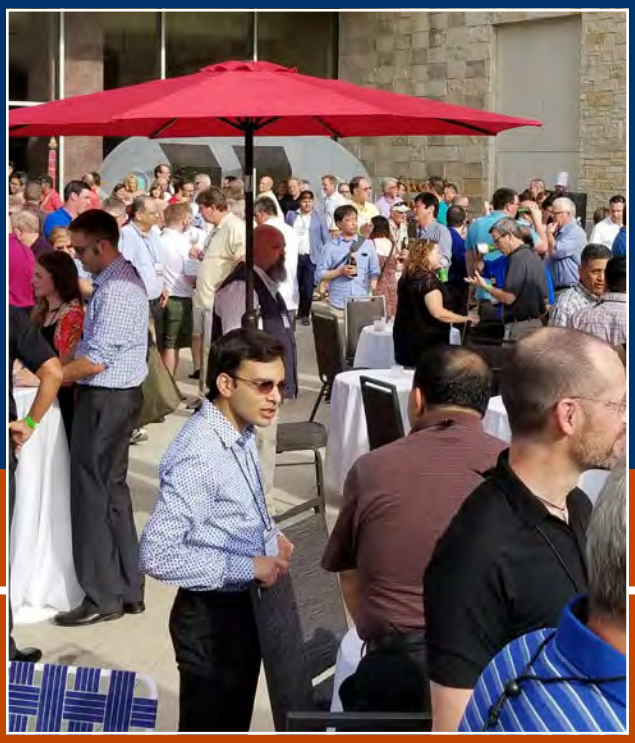
Continuing our quest to introduce the science of PM to students, 40 National Science Foundation (NSF) and 4 CPMT/Axel Madsen Conference Grant recipients will prepare project posters on PM & metal AM to be displayed during the conference. Additionally, each recipient will present a 10-minute synopsis of the poster during a scheduled Grant TNT: Talk 'N Technology. Grant recipients and their poster titles will be available on the conference website.

MPIF is grateful to the National Science Foundation for its support of students to attend the POWDERMET2019 & AMPM2019 annual conferences. This support provides student participants with opportunities to exchange ideas with leading researchers and engineers from worldwide industrial and governmental facilities, as well as with students and faculty from both domestic and international universities. Student participants will learn the latest research areas and results in powder metallurgy fields of interest. These opportunities will not only improve the students' knowledge in the field, but also develop scientists and engineers who are ideally suited to create the next generation of designs in powder metallurgy and metal additive manufacturing that will push materials and manufacturing capabilities.

The Axel Madsen Conference Grant Program was established by the Madsen family to encourage students to learn more about PM technology and eventually pursue careers in the PM industry.

Make the Most of Your Conference Experience

From attendees to exhibitors or from speakers to students, networking is one of the most important functions of a conference. Form or strengthen relationships, get face-to-face time with customers or students, and ask follow-up questions to researchers in your field. Gain customers, suppliers, colleagues, or mentors.



Networking Opportunities

■ **OPENING NIGHT RECEPTION**
Don't miss the kick-off celebration to the entire conference as attendees are welcomed to Phoenix. Say hello to old and new friends and learn the latest industry buzz.

■ **PM DESIGN EXCELLENCE AWARDS LUNCHEON**
A luncheon highlighting the winners of the 2019 PM Design Excellence Awards that provides an opportunity to learn about new uses of PM and the top companies in the industry.

■ **PM EVENING ALEHOUSE**
Grab a beverage and shake hands with exhibitors, poster authors, and fellow attendees.

■ **INDUSTRY LUNCHEON**
A luncheon recognizing key industry individuals, this luncheon is an opportunity to connect big names with faces.

■ **CLOSING EVENT—Rhinestone Rodeo!**
Grab your rope and spurs and head over to the biggest social event of the conference! This is an ideal time to connect with other attendees and discuss all that you've learned throughout the conference. This is a fun and unique way to connect and network with your fellow PM/AM industry peers.

Conference Networking 101

■ **PREPARE. PREPARE. PREPARE.**
1. Download the Conference App.
2. Review the program.
3. Find out who's going.
4. Schedule meetings at the AM/PM Café.

■ **ONCE YOU'RE THERE**
1. Connect with colleagues and/or customers.
2. Utilize evening social events—the informal setting is a good way to get to know people.
3. Don't hesitate to ask questions or seek out speakers or exhibitors at social events.
4. Make time to attend the exhibit hall.
5. Visit the poster sessions.

■ **POST-CONFERENCE**
1. Follow up with people you met by connecting on LinkedIn or sending them a quick email.
2. Share what you have learned with co-workers.

TIP: Put Away the Smartphone—nothing beats face-to-face interaction.

GENERAL INFORMATION

CONFERENCE VENUE & HEADQUARTERS HOTEL
All conference events will take place at:

Sheraton Grand Phoenix
340 N. 3rd Street
Phoenix, AZ 85004
602-262-2500

REGISTRATION
- Register and reserve hotel rooms at POWDERMET2019.org or AMPM2019.org.
- Advance registration discounts are for a limited time and will guarantee participation in selected events.
- Payment must accompany registration by May 10 to qualify for lowest rates.
- Rates increase after May 10.
- Higher rates apply for registration on site.
- MPIF and APMI International members receive discounted rates.
- Children under the age of 17 will not be permitted.

FULL THREE-DAY CONFERENCE REGISTRATION
The POWDERMET2019/AMPM2019 conference registration fee includes:
- Opening General Session and technical events for both co-located conferences (POWDERMET2019 & AMPM2019)
- Exhibit hall admission
- Meal functions: Opening Night Reception, Industry and PM Design Excellence Awards Luncheons, PM Evening Alehouse, and the Closing Event—Rhinestone Rodeo!
- Registration bag with handout materials
- Post-conference digital proceedings for POWDERMET2019 and AMPM2019 technical manuscripts

DAILY REGISTRATION
Daily rates include:
- Opening General Session (where applicable) and technical events for both co-located conferences (POWDERMET2019 & AMPM2019)
- Exhibit hall admission, including the PM Evening Alehouse (if applicable)

Daily rates do not include luncheons, Opening Reception, dinner events, or manuscript proceedings. Meal tickets and proceedings may be purchased separately.

SPOUSE REGISTRATION
Spouse registration is designed to allow significant others, not affiliated with the PM industry, to join you at the Opening Night Reception, the Closing Event—Rhinestone Rodeo!, and the exhibit hall, including the PM Evening Alehouse.

All registrations will be acknowledged by e-mail. **Important:** If you do not receive an acknowledgment within 4–7 days, please contact Stephanie Schember at sschember@mpif.org.

STUDENT REGISTRATION
(Non-NSF/CPMT Grant Recipients)

The student rate includes:
- Opening General Session and technical events for both co-located conferences (POWDERMET2019 & AMPM2019)
- Exhibit hall admission
- Industry Luncheon, the PM Design Excellence Award Luncheon, and the PM Evening Alehouse*
- Post-conference digital proceedings for POWDERMET2019 and AMPM2019 technical manuscripts
- Registration bag with handouts

To qualify for the student rate, you must:
- Be enrolled as a full-time engineering student who is not employed in the industry
- Provide proof of active student status with your conference registration
- Provide the university name as your organization when you register for the conference

**Meal tickets for the Opening Night Reception and the Closing Event—Rhinestone Rodeo! are not included in the student package. These tickets must be purchased separately.*

LET PHOENIX SURPRISE YOU!

Although Phoenix sits within the Sonoran Desert, there is more to see and do in this stunning desert backdrop. Downtown Phoenix has been brought to life, giving its visitors more restaurants and bars to explore, great music to discover and stunning street art to stumble upon. As Arizona's urban center, Downtown Phoenix provides unique year-round experiences thanks to a rich history, diverse culture and fantastic art community. Come early or stay longer so that you can enjoy all that the city has to offer!

Have you ever...

- wanted to hike up the hump of a camel? Camelback Mountain is a prominent landmark in Phoenix. The mountain, which summits at 2,704 feet above sea level, resembles the hump and head of a kneeling camel.
- wanted to see a 50-foot tall cactus that can live up to 200 years? The Saguaro Cactus, found in Sonoran Desert, can't be found in any other desert in the world.
- wanted to see a major professional sporting event before or after the conference? You are in luck—Phoenix is one of the few U.S. cities with franchises in all four major professional sports leagues: Phoenix Suns (NBA), Arizona Diamondbacks (MLB), Arizona Cardinals (NFL) and Arizona Coyotes (NHL).
- wanted to visit the MIM Museum? The Musical Instrument Museum (MIM) tunes you into thousands of instrument sounds with a headset that syncs seamlessly as you move throughout the gallery.

MEAL TICKET SALES
Additional tickets for the Opening Night Reception, the Industry and PM Design Excellence Awards Luncheons, and the Closing Event—Rhinestone Rodeo! will be available for purchase only to:

- Daily registrants
- POWDERMET/AMPM conference registrants
- Accompanying spouses/guests of full-conference registrants
- Exhibitor personnel
- Students

Individual meal ticket sales are intended as add-ons to existing conference registrations. Individuals who are not conference registrants, as listed above, will not be able to purchase meal tickets.

ADMISSION TO EXHIBIT HALL

- Admission to the exhibit hall is included as part of full-conference and daily registration rates.
- Exhibit-only admission is not available for purchase.
- Qualified PM parts manufacturers are eligible for complimentary exhibit passes. Please visit POWDERMET2019.org or AMPM2019.org for details.

CANCELLATIONS AND REFUNDS

- Registration cancellations and refunds are only accepted in writing.
- If you cancel by telephone, you must still confirm by email or fax at the time of cancellation in order to receive a refund.
- A $325 cancellation fee will be deducted from refunds on all cancellations received through June 7 (no refunds for the APMI Golf Tournament). No refunds will be given after this date.
- Individuals who fail to cancel in writing by June 7 and do not attend the conference will be subject to the full fee.

Important: If you do not receive a cancellation acknowledgment within 2–3 business days, please contact Stephanie Schember at sschember@mpif.org.

REQUEST FOR FOREIGN VISAS
Some travelers entering the U.S. must obtain a visa and should apply for a visa as early as possible due to U.S. government increased security and entry requirements. Request a special letter of invitation at POWDERMET2019.org or AMPM2019.org.

For further questions, contact Stephanie Schember at sschember@mpif.org.

SUGGESTED DRESS
Business or business casual attire is appropriate for all conference events. Casual attire (shorts permitted) is appropriate for the Closing Event—Rhinestone Rodeo!

PEOPLE WITH DISABILITIES
Attendees with disabilities that require special needs should contact MPIF (dhaggerty@mpif.org) in advance so that arrangements can be made.

HOTEL RESERVATIONS
Register early to guarantee group rates at the hotel. Higher rates may apply once our room block is filled or after the advance registration deadline of May 10. Room reservations will be acknowledged by email. Hotel rooms before and after the conference may be available but at a higher rate.

SPECIAL CONFERENCE RATE
Single or Double: $144.00 plus taxes per night.

Hotel reservations, changes, and cancellations

- Credit card information is required in order to process your reservation. Your card will be charged the first night's room and tax as a deposit by the hotel.
- This deposit is refundable for cancellations received at least 48 hours prior to the confirmed day of arrival and cancellation number is obtained.
- For changes to your reservations or to cancel, contact the Sheraton Grand Phoenix.

STAY AT THE HEADQUARTERS HOTEL
You are highly encouraged to stay at the Sheraton Grand Phoenix—the headquarters hotel. Not only will you be at the center of all the activities, but the convenience far outweighs any benefits from staying at other hotels. Please help your association meet its contracted obligations by staying at the headquarters hotel.

CODE OF CONDUCT POLICY
Presenters, Vendors and all other Attendees at MPIF/APMI/CPMT events are expected to comply with instructions from staff members, and are expected to conduct themselves at all times in a courteous, professional and respectful manner, refraining from language and conduct that might bring discredit upon themselves, their organizations, and MPIF/APMI/CPMT. Such conduct includes, but is not limited to disrupting the businesslike atmosphere, harassment, discrimination, inappropriate language, failing to comply with local, state, and federal laws, and conduct that puts themselves and others at risk. This code of conduct applies to both official activities of the event and its program as well as to any informal and social activities taking place in connection with the event. Presenters, and any other Attendees who do not comply with this code of conduct may be removed from the event and barred from attending future MPIF/APMI/CPMT sponsored or co-sponsored events.

14th Annual APMI International Golf Tournament

14TH ANNUAL APMI GOLF TOURNAMENT
APMI INTERNATIONAL
JUNE 23, 2019 PHOENIX, AZ

Revered as the crown jewel or Scottsdale, the challenge, visual sensation and special ambiance of Troon North sets the standard by which all other courses are measured. Recent course renovations by original designer and British Open Champion Tom Weiskopf has created a new layout to bring back the classic desert golf experience. Stretching through natural ravines and foothills in the shadows of Pinnacle Peak, the giant granite boulders lie strewn across the rugged landscape of Arizona's Sonoran Desert, providing a standard unmatched in the American Southwest. Whether you are playing for the first time or a regular, Troon North in sunny Arizona offer golf connoisseurs the best in desert golf!

Attendees may register as foursome or as individuals. To sponsor a foursome, please contact Diane Haggerty (dhaggerty@mpif.org).

TROON NORTH GOLF OUTING
Sunday, June 23
8:00 a.m.–2:00 p.m.
(Bus departure 6:30 a.m.)

Attire: Course dress code is soft spikes, slacks, Bermuda shorts, and shirts with sleeves and collar.

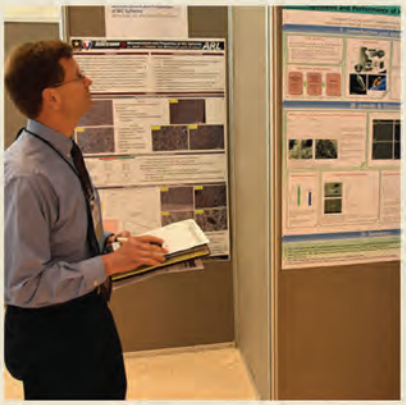
Cancellation Policy: There are no refunds for cancellation of the golf tournament.

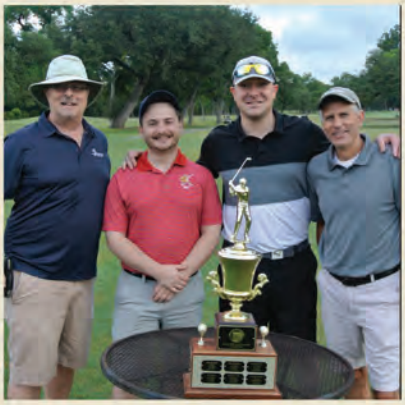
Tournament Fee: $140.00—includes transportation, breakfast, greens fees and cart.

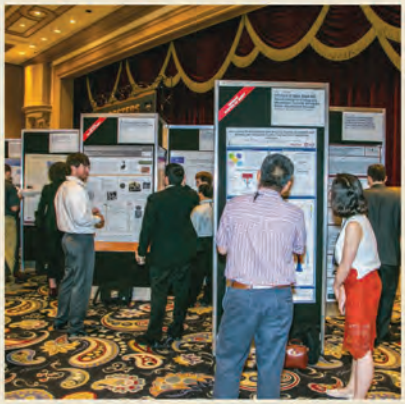
Rental Clubs: $50.00 per set

Participation in the tournament may be limited. Sign up early to reserve your spot!

Be a Part of the Action...







POWDERMET2019
Phoenix

Held in conjunction with:

AM 2019 PM
Additive Manufacturing With Powder Metallurgy

...Register Today!

REGISTRATION FEES AND TICKET PRICES

	ADVANCE PAID BY MAY 10	AFTER MAY 10	ON-SITE REGISTRATION
FULL CONFERENCE REGISTRATION *(Includes Opening Night Reception, PM Evening Alehouse, Opening General Session, POWDERMET and AMPM technical sessions, two luncheons, exhibit, Closing Event, POWDERMET and AMPM proceedings, and registration bag with handouts)*			
MPIF-MEMBER COMPANY EMPLOYEES	$1,600	$1,700	$1,850
MPIF-Member *(Speakers/Session Chairmen)*	1,500	1,700	1,850
APMI Member	1,700	1,800	1,950
APMI Member *(Speakers/Session Chairmen)*	1,600	1,800	1,950
Non-Member	2,000	2,100	2,250
Non-Member *(Speakers/Session Chairmen)*	1,900	2,100	2,250
NEW! **Metal AM Tutorial (*Optional*)** Explore the opportunities associated with developing a metal AM manufacturing facility.	200	300	400
EXHIBITOR REGISTRATION *(for exhibitor booth staff)*			
Exhibitor Package 1 *(Opening Night Reception, PM Evening Alehouse, Opening General Session, two technical sessions, two luncheons, Closing Event, and registration bag w/handouts)*	$875	$900	$925
Exhibitor Package 2 *(Opening General Session, PM Evening Alehouse, two technical sessions, two luncheons, and registration bag w/handouts)* ▶ Opening Reception and Closing Event purchased separately.	375	400	425
Spouse Registration *(Includes Opening Night Reception, PM Evening Alehouse and Closing Event)*	500	525	550
Student Registration *(Opening General Session, PM Evening Alehouse, technical sessions, two luncheons, exhibit, POWDERMET and AMPM proceedings, and registration bag w/handouts) (For details and to determine eligibility, visit POWDERMET2019.org.)* ▶ Opening Reception and Closing Event purchased separately.	200	250	300
Daily Registration *(Includes technical sessions and exhibit only, plus registration bag with handouts.)* ▶ Purchase meals or proceedings separately.			
Monday	$850	$900	$950
Tuesday	850	900	950
Wednesday	850	900	950
Exhibit-Only Admission *Free to qualified PM parts manufacturers only (contact MPIF for details). Exhibit is included with full or daily packages above.*			
POWDERMET2019 or AMPM2019 Digital Conference Proceedings *(Included with full-conference and student registration, cost for additional copies)*	$750	$750	$750
Meal Tickets *(Meals are available only to full conference registrants, spouses, students, and exhibitor personnel)*			
Sunday: **Opening Night Reception**	$150	$160	$175
Monday: **PM Design Excellence Awards Luncheon**	80	85	95
Tuesday: **Industry Luncheon**	80	85	95
Tuesday: **Closing Event—Rhinestone Rodeo!**	375	385	400
APMI Golf Tournament (Sunday)			
Tournament Fee	$140	$140	–
Club Rental	50	50	–

REGISTER AND RESERVE HOTEL ONLINE AT POWDERMET2019.ORG or AMPM2019.ORG

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POWDERMET2019 Phoenix

International Conference
on Powder Metallurgy
& Particulate Materials

AMPM 2019 Additive Manufacturing With Powder Metallurgy

Additive Manufacturing
with Powder Metallurgy

PROGRAM & REGISTRATION INFORMATION

June 23–26, 2019
Sheraton Grand • Phoenix, Arizona

For program details visit: POWDERMET2019.org or AMPM2019.org