Two Big Conferences Under One Roof!

PROGRAM & REGISTRATION INFORMATION

International Conference on Powder Metallurgy & Particulate Materials
Additive Manufacturing with Powder Metallurgy

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

For program details visit: POWDERMET2019.org or AMPM2019.org
Need enhanced material performance?
Looking for unique alloys with novel properties?
Interested in lightweight solutions?

info@kymerainternational.com

Under new ownership, Kymera International is seeking acquisition opportunities both big and small to complement its global leading material science portfolio.

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.
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

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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. (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/Variation 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 CAFE: Coffee Served

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

9:00–11:45 a.m.
GRANT TNT: Talk ‘N Technology—Part 3

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

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

1:45–3:15 p.m.
PM CAFE: 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
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)
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

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)
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.

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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.
## Exhibitors

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Location</th>
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<tbody>
<tr>
<td>ABBOTT FURNACE COMPANY</td>
<td>St. Marys, PA</td>
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<td>ABTEX CORPORATION</td>
<td>Dresden, NY</td>
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<td>AIR PRODUCTS AND CHEMICALS, INC.</td>
<td>Allentown, PA</td>
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<td>ALD VACUUM TECHNOLOGIES, INC.</td>
<td>East Windsor, CT</td>
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<td>AMERICAN CHEMET CORPORATION</td>
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<td>AMETEK SPECIALTY METAL PRODUCTS</td>
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<td>ANTON PAAR</td>
<td>Ashland, VA</td>
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<td>ASBURY CARBONS</td>
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<td>ATI POWDER METALS</td>
<td>Oakdale, PA</td>
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<td>BFG MANUFACTURING</td>
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<td>BLASCH PRECISION CERAMICS</td>
<td>Albany, NY</td>
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<td>BRONSON &amp; BRATTON, INC.</td>
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<td>BRUKER AXS</td>
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<td>CARPENTER TECHNOLOGY CORPORATION</td>
<td>Bridgeville, PA</td>
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<td>CENTORR VACUUM INDUSTRIES, LLC</td>
<td>Nashua, NH</td>
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<td>CHUNG YI MOLD (SUZHOU) CO., LTD.</td>
<td>Jiangsu Province, China</td>
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<td>CINCINNATI INCORPORATED</td>
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<td>CM FURNACES, INC.</td>
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<td>CNPC POWDER NORTH AMERICAN INC.</td>
<td>Vancouver, British Columbia, Canada</td>
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<td>COOKSONGOLD</td>
<td>Birmingham, United Kingdom</td>
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<td>DORST AMERICA, INC.</td>
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<td>GERARD DANIEL WORLDWIDE</td>
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<td>WUXI CITY SINCERE REFRACTORY CERAMICS CO., LTD.</td>
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(Listing as of January 25, 2019)
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](image1)
Daniel Reardon
Abbott Furnace Company

![Virendra Warke](image2)
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.*

**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.

**AMPM TECHNICAL SESSIONS**

**CONFERENCE CHAIRMEN:**

![Mathieu Brochu](image3)
Mathieu Brochu
McGill University

![Juha Kotila](image4)
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.*

**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.

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Germain Materials Technology

Anil Giri
U.S. Army Research Laboratory

Ryutisuke Goto
Engineered Sintered Components

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North American Höganäs Co.

Bo Hu
North American Höganäs Co.

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Royal Metal Powders Inc.

Nicholas Hunt
Catalus Corporation

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AAM®-Powertrain

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PMtech

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Koehler Associates

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Dorst America, Inc.

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Western Sintering Co., Inc.

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Hoeganaes Corporation

Kalathur Narasimhan, FAPMI
P2P Technologies

Jose Correa Neto
Miba Sinter Brasil Ltda

Roger Neyman
Catalus Corporation

Salvator Nigarura
Catalus Corporation

Roger Neyman
Catalus Corporation

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Atlas Pressed Metals

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Bronson & Bratton, Inc.

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Engineered Sintered Components

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Drexel University

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PentaMet Associates LLC

Rohith Shivanath
Stackpole International

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Michael Stawowy
H. C. Starck Inc.

Blaine Stebick
Phoenix Sintered Metals LLC

John Stenulis
Dotcom America, Inc.

Therese Stephenson
Rio Tinto Metal Powders

Craig Stringer
Atlas Pressed Metals

S. K. Tam
Orrico

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

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Sandvik Osprey Limited

Martin Kears
Sandvik Osprey Limited

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MPP

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Carpenter Technology Corporation

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ExOne

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Luxfer Magtech

Michael Marucci
Ametek Reading Alloys

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General Motors Corporation

Dustin Yetzer
Abbott Furnace Company

Antonios Zavallangos
Drexel University
# Technical Sessions

**Monday Morning, 9:30–10:45 a.m.**

**SESSION 01: Ferrous Materials and Properties I**

**Session Chairman:** Craig Stringer, Atlas Pressed Metals

<table>
<thead>
<tr>
<th>Session No.</th>
<th>Country</th>
<th>Time</th>
<th>Title</th>
<th>Speaker(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>185 USA</td>
<td>9:30 a.m.</td>
<td>USA</td>
<td>Development of High-Strength PM Alloy That Competes with Wrought 8620 Alloy in Structural Applications</td>
<td>Brad Morningstar, MPP</td>
</tr>
<tr>
<td>182 USA</td>
<td>9:55 a.m.</td>
<td>USA</td>
<td>Fatigue Performance of a Sinter-Hardened Powdered Metal Steel</td>
<td>Ian Donaldson, FAPMI, GKN Sinter Metals</td>
</tr>
<tr>
<td>119 USA</td>
<td>10:20 a.m.</td>
<td>USA</td>
<td>Effect of Reducing Nickel in Current PM Materials</td>
<td>Neal Kraus, Hoeganaes Corporation</td>
</tr>
</tbody>
</table>

**SESSION 02: Atomization I**

**Session Chairman:** John Meyer, Carpenter Technology Corporation

<table>
<thead>
<tr>
<th>Session No.</th>
<th>Country</th>
<th>Time</th>
<th>Title</th>
<th>Speaker(s)</th>
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</thead>
<tbody>
<tr>
<td>103 USA</td>
<td>9:30 a.m.</td>
<td>USA</td>
<td>Production and Characteristics of Atomized Submicrometer Alloy Powders</td>
<td>Randall M. German, FAPMI, German Materials Technology</td>
</tr>
<tr>
<td>133 USA</td>
<td>9:55 a.m.</td>
<td>USA</td>
<td>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</td>
<td>Trevor M. Riedemann, Ames Laboratory (USDOE)</td>
</tr>
<tr>
<td>147 USA</td>
<td>10:20 a.m.</td>
<td>USA</td>
<td>Results of Satellite Reduction Strategy on Gas-Atomized Powder Quality for Additive Manufacturing</td>
<td>Iver E. Anderson, FAPMI, Ames Laboratory (USDOE)</td>
</tr>
</tbody>
</table>

**SESSION 03: Sintering Furnace Design and Atmospheres**

**Session Chairman:** Kester Clarke, Colorado School of Mines

<table>
<thead>
<tr>
<th>Session No.</th>
<th>Country</th>
<th>Time</th>
<th>Title</th>
<th>Speaker(s)</th>
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</thead>
<tbody>
<tr>
<td>158 USA</td>
<td>9:30 a.m.</td>
<td>USA</td>
<td>Controlled Atmosphere Technologies for Sintering High-Quality Components by Proper Lubrication and Lean Sintering Atmospheres</td>
<td>Akin Malas, Linde LLC</td>
</tr>
<tr>
<td>186 USA</td>
<td>9:55 a.m.</td>
<td>USA</td>
<td>A Review of Lubricant Removal Systems and the Latest Technology</td>
<td>Stephen L. Feldbauer, Abbott Furnace Company</td>
</tr>
<tr>
<td>059 India</td>
<td>10:20 a.m.</td>
<td>India</td>
<td>Precision Bronze Sintering Furnace Design</td>
<td>Ravi P. Malhotra, Sr., Malhotra Engineers</td>
</tr>
</tbody>
</table>
## SPECIAL INTEREST PROGRAM

**Monday Morning  9:30–10:45 a.m.**

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<tr>
<th>SIP 1</th>
<th>Additive Machines, Capabilities and Processes</th>
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</thead>
</table>
|       | **Program Organizers:** Joseph Capone, Ametek, Inc.  
         Stuart Jackson, Renishaw Inc.  
         Aaron LaLonde, SLM Solutions NA, Inc. |
|       | **Session Chairman:** Aaron LaLonde, SLM Solutions NA, 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.  
         Additive Manufacturing for Growth Acceleration in the Powder Metallurgy Industry  
         Sundar V. Atre, University of Louisville |
| 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.  
         Additive Manufacturing for Growth Acceleration in the Powder Metallurgy Industry  
         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 |

### SESSION 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 Spreadability, 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 |
**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)

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**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 preventative additives 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.

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**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.**

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<tr>
<th>Session</th>
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<th>Time</th>
<th>Location</th>
<th>Speaker</th>
<th>Presentation</th>
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</thead>
<tbody>
<tr>
<td>A07</td>
<td>Nickel Alloys II</td>
<td>4:30 p.m.</td>
<td>USA</td>
<td>Ronald Aman, Carpenter Technology Corporation</td>
<td>Influence of Alloy 718 Powder Size on Density, Microstructure, Mechanical Properties, and Production Costs in Metal AM</td>
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<td>A08</td>
<td>Exploratory Metal Powder Production</td>
<td>4:30 p.m.</td>
<td>USA</td>
<td>Marc S. Pepi, U.S. Army Research Laboratory</td>
<td>Progress Towards Expeditionary Production of AM-Grade Metallic Powder</td>
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<td>A09</td>
<td>Modeling of Metal AM II</td>
<td>4:30 p.m.</td>
<td>USA</td>
<td>Lingbin Meng, Indiana University—Purdue University Indianapolis (IUPUI)</td>
<td>Machine Learning-Enabled Molecular Dynamics Simulation of Laser Powder Bed Fusion Additive Manufacturing of Inconel718</td>
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<td>SESSION 06</td>
<td>Monday Morning</td>
<td>8:00–9:15 a.m.</td>
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<td><strong>Ferrous Materials and Properties III</strong></td>
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<td>Session Chairman: Julie Campbell-Tremblay, PMT, Rio Tinto Metal Powders</td>
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<td>083 USA</td>
<td>8:00 a.m.</td>
<td>Manufacturing Methods for High-Density Powdered Metal (PM) Applications and Their Effect on Mechanical Properties</td>
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<td>Amber Tims, PMT, North American Höganäs Co.</td>
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<tr>
<td>168 Canada</td>
<td>8:25 a.m.</td>
<td>Optimization of Liquid-Phase Sintering of Boron PM Steels Using Master Alloys</td>
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<td>Simon Gelinas, Université Laval</td>
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<tr>
<td>183 USA</td>
<td>8:50 a.m.</td>
<td>A Method to Estimate Fatigue Axial Properties for Ferrous Powder Metal Materials</td>
<td></td>
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<tr>
<td>Virgiliu A. Savu, GKN Sinter Metals</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>SESSION 07</th>
<th>Monday Morning</th>
<th>8:00–9:15 a.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MIM I</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Session Chairman: Michael Wiseman, ARC Group Worldwide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>057 USA</td>
<td>8:00 a.m.</td>
<td>Simulation and Experimental Verification of Two Cavity Balance in Injection Molding</td>
</tr>
<tr>
<td>Neal S. Myers, Kennametal, Inc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>016 USA</td>
<td>8:25 a.m.</td>
<td>5 Reasons to Celebrate Mold Cleaning in Power Injection Molding</td>
</tr>
<tr>
<td>Steve Wilson, Cold Jet LLC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>200 United Kingdom</td>
<td>8:50 a.m.</td>
<td>Developments in High-Temperature Nickel Alloys for MIM Applications</td>
</tr>
<tr>
<td>Martin A. Kearns, Sandvik Osprey Limited</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SESSION 08</th>
<th>Monday Morning</th>
<th>8:00–9:15 a.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Non-Traditional Alloy Sintering</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Session Chairman: Raymond Serafini, PMT, Linde, LLC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>068 USA</td>
<td>8:00 a.m.</td>
<td>Commercial Sintering of Chromium Powder Metallurgy (PM) Steels</td>
</tr>
<tr>
<td>135 USA</td>
<td>8:25 a.m.</td>
<td>Effects of Sintering Conditions on the Diffusion Bonding of AgC-Cu Electrical Contacts</td>
</tr>
<tr>
<td>Daudi R. Waryoba, The Pennsylvania State University</td>
<td></td>
<td></td>
</tr>
<tr>
<td>187 USA</td>
<td>8:50 a.m.</td>
<td>High-Strength Aluminum-Zinc Composite PM Grade with Trace Amount of Copper for Powder Metallurgy Applications</td>
</tr>
<tr>
<td>Jessu Joys, United States Metal Powders, Inc.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Session A10: Aluminum Alloys

<table>
<thead>
<tr>
<th>Session Chairman:</th>
<th>Session Name</th>
<th>Country</th>
<th>Time</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>S.K. Tam, ORMCO</td>
<td>High-Performance Aluminum Alloys by Additive Manufacturing</td>
<td>Finland</td>
<td>8:00 a.m.</td>
<td>Improved Production Methods for Powders Used in Additive Manufacturing</td>
<td>Juha Kotila, EOS Finland</td>
</tr>
<tr>
<td></td>
<td></td>
<td>USA</td>
<td>8:25 a.m.</td>
<td>Investigation of the Selective Laser Melting Process for AlSi10Mg and AA6061 Fabricated at High Laser Power</td>
<td>Michael V. Pires, Lehigh University</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Canada</td>
<td>8:50 a.m.</td>
<td>Water-Atomized Metal Powders for PM, AM and MIM: Improvements and Potential Markets</td>
<td>Chantal Labrecque, Rio Tinto Metal Powders</td>
</tr>
</tbody>
</table>

### Session A11: NDT Methods Applied to AM Powders and Components

<table>
<thead>
<tr>
<th>Session Chairman:</th>
<th>Session Name</th>
<th>Country</th>
<th>Time</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michael Stucky, Norwood Injection Technologies</td>
<td>Quantification of Contaminants in 3D Printing Metal Powders Using Microfocus X-Ray Tomography</td>
<td>Canada</td>
<td>8:00 a.m.</td>
<td>Assessing Post-Processing States of AM Builds with Analysis of Ultrasonic Dispersion Properties</td>
<td>Ajay V. Krishnan, Incodema3D, LLC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>USA</td>
<td>8:25 a.m.</td>
<td>NDT of Metal Additively Manufactured Parts via Acoustic Resonance Testing</td>
<td>Bryan Butsch, The Modal Shop, Inc.</td>
</tr>
</tbody>
</table>

### Session A12: Metal AM: Processes and Applications

<table>
<thead>
<tr>
<th>Session Chairman:</th>
<th>Session Name</th>
<th>Country</th>
<th>Time</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyrum Lefler, Carpenter Technology Corporation</td>
<td>Manufacturing, Remanufacturing and Reconfiguration of Aerospace Components with Direct Metal Deposition (DMD)</td>
<td>USA</td>
<td>8:00 a.m.</td>
<td>Fused-Filament Fabrication of Metal with a Markforged Metal X System</td>
<td>Michelle Chao, Markforged</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Germany</td>
<td>8:50 a.m.</td>
<td>3D Screen Printing of Metal Powder</td>
<td>Guido Stiebritz, H.C. Starck Hermsdorf GmbH</td>
</tr>
</tbody>
</table>

### Special Interest Program (SIP 2-1): Powder Production for AM, PM, MIM: Differences, Similarities and Synergies

<table>
<thead>
<tr>
<th>Program Organizers:</th>
<th>Title</th>
<th>Country</th>
<th>Time</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carl Blais, Laval University</td>
<td>Powder Production for AM, PM, MIM: Differences, Similarities and Synergies</td>
<td></td>
<td></td>
<td>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.</td>
<td>Denis Christopherson, Federal-Mogul Sintered Products</td>
</tr>
</tbody>
</table>
Schedule-at-a-Glance

SUNDAY

APMI Golf Tournament

MONDAY

OPENING GENERAL SESSION — KEYNOTE PRESENTATION

01: Ferrous Mat & Prop I
02: Atomization I
03: Sint Furn Des & Atmos

SIP 1-1

A01: Alloy Development
A02: Process & Properties
A03: Char Meth-AM Pow Comp

PM DESIGN EXCELLENCE AWARDS LUNCHEON

04: Ferrous Mat & Prop II
05: Atomization II
Management Session

CPMT Present Management Session

A04: Nickel Alloys I
A05: Solid State Proc
A06: Model of Metal AM I

A07: Nickel Alloys II
A08: Expl Metal Pow Prod
A09: Model of Metal AM II

PM Cafe EXHIBIT

A07: Nickel Alloys II
A08: Expl Metal Pow Prod
A09: Model of Metal AM II

Poster Authors PM Evening Alehouse

Grant TNT

AM Cafe EXHIBIT

PMPA Membership Meeting

Grant TNT

PM Cafe EXHIBIT

8 am 7 am 9 am 10 am 11 am 12 noon 1 pm 2 pm 3 pm 4 pm 5 pm 6 pm 7 pm 8 pm
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

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)

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

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.**

<table>
<thead>
<tr>
<th>Session</th>
<th>Title</th>
<th>Country</th>
<th>Time</th>
<th>Speaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIP 2-2</td>
<td><strong>Powder Production for AM, PM, MIM: Moving Away from Two-Fluid Atomization</strong></td>
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<tr>
<td></td>
<td>Program Organizers: Carl Blais, Laval University; Gilles L'Esperance, FAPMI, Ecole Polytechnique de Montreal</td>
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<tr>
<td></td>
<td>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.</td>
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<tr>
<td></td>
<td><strong>Session Chairman:</strong> Gilles L'Esperance, FAPMI, Ecole Polytechnique de Montreal</td>
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<tr>
<td>195</td>
<td>Canada 10:30 a.m. Powders Production and Characterization Methods for AM</td>
<td>Canada</td>
<td>10:30 a.m.</td>
<td>Jérôme Pollak, Tekna Advanced Materials, Inc.</td>
</tr>
<tr>
<td>196</td>
<td>Canada 10:55 a.m. Solving AM Challenges with Plasma Atomization</td>
<td>Canada</td>
<td>10:55 a.m.</td>
<td>Frédéric Marion, AP&amp;C</td>
</tr>
<tr>
<td>197</td>
<td>Canada 11:20 a.m. Description of Various Additive Manufacturing Applications Made with Powders Produced with a Proprietary Atomizing Technology</td>
<td>Canada</td>
<td>11:20 a.m.</td>
<td>Amir Nobari, 5N Plus Micro Powders</td>
</tr>
</tbody>
</table>

### AMPM Technical Sessions

**Tuesday Morning 10:30–11:45 a.m.**

<table>
<thead>
<tr>
<th>Session</th>
<th>Title</th>
<th>Country</th>
<th>Time</th>
<th>Speaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>SESSION A13</td>
<td><strong>Biomedical Applications</strong></td>
<td>United Kingdom</td>
<td>10:30 a.m.</td>
<td>Enrique Alabort, OxMet Technologies</td>
</tr>
<tr>
<td></td>
<td><strong>Session Chairman:</strong> Katie Jo Sunday, Hoeganaes Corporation</td>
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<tr>
<td>040</td>
<td>United Kingdom 10:30 a.m. Alloys-by-Design: a Biomedical Titanium Alloy for Additive Manufacturing</td>
<td>United Kingdom</td>
<td>10:30 a.m.</td>
<td>Timothy E. Prost, Ames Laboratory</td>
</tr>
<tr>
<td>072</td>
<td>Finland 10:55 a.m. Increasing Fatigue Life of Additively Manufactured CoCrMo Alloy with Affordable Heat Treatment</td>
<td>Finland</td>
<td>10:55 a.m.</td>
<td>Andrzej L. Wojcieszynski, ATI Specialty Materials</td>
</tr>
<tr>
<td>098</td>
<td>USA 11:20 a.m. 3D Printing of Biomimetically Inspired Zircon for Ceramic Mold Components</td>
<td>USA</td>
<td>11:20 a.m.</td>
<td>Tejesh C. Dube, Indiana University—Purdue University Indianapolis (IUPUI)</td>
</tr>
<tr>
<td>SESSION A14</td>
<td><strong>Recycling of AM Powders I</strong></td>
<td>USA</td>
<td>11:20 a.m.</td>
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<tr>
<td></td>
<td><strong>Session Chairman:</strong> Alan Taylor, GKN Sinter Metals</td>
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</tr>
<tr>
<td>112</td>
<td>USA 10:30 a.m. Powder Reconditioning of AM Feedstock to Increase Processing Efficiency</td>
<td>USA</td>
<td>10:30 a.m.</td>
<td></td>
</tr>
<tr>
<td>071</td>
<td>USA 10:55 a.m. Recyclability of Ti-48Al-2Nb-2Cr Powder in Additive Manufacturing</td>
<td>USA</td>
<td>10:55 a.m.</td>
<td></td>
</tr>
<tr>
<td>201</td>
<td>United Kingdom 11:20 a.m. Development of Enhanced Tool Steels for Powder Bed Fusion Additive Manufacturing</td>
<td>United Kingdom</td>
<td>11:20 a.m.</td>
<td>Martin A. Kearns, Sandvik Osprey Limited</td>
</tr>
<tr>
<td>SESSION A15</td>
<td><strong>Process Enhancement and Monitoring</strong></td>
<td>United Kingdom</td>
<td>10:30 a.m.</td>
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<tr>
<td></td>
<td><strong>Session Chairman:</strong> Bhaskar Dutta, DM3D Technology, LLC</td>
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</tr>
<tr>
<td>095</td>
<td>United Kingdom 10:30 a.m. Real-Time Process Monitoring Accelerates Process Development and Streamlines Process Control</td>
<td>United Kingdom</td>
<td>10:30 a.m.</td>
<td></td>
</tr>
<tr>
<td>129</td>
<td>USA 10:55 a.m. Improving Productivity in Laser Powder Bed Fusion Systems</td>
<td>USA</td>
<td>10:55 a.m.</td>
<td></td>
</tr>
<tr>
<td>172</td>
<td>USA 11:20 a.m. In-Process Monitoring for Laser Metal Deposition</td>
<td>USA</td>
<td>11:20 a.m.</td>
<td></td>
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</table>
## POWDERMET TECHNICAL SESSIONS

### Tuesday, June 25

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

<table>
<thead>
<tr>
<th>Session 12</th>
<th>Time</th>
<th>USA/Country</th>
<th>Title</th>
<th>Speaker(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>061</td>
<td>3:15 p.m.</td>
<td>Investigation of Powder Processing, Heat Treating, and Texturing to Improve Gas-Atomized Alnico Magnets for Use in Electric Drive Motors</td>
<td>Emily A. Rinko, Iowa State University</td>
<td></td>
</tr>
<tr>
<td>132</td>
<td>3:40 p.m.</td>
<td>Multistage Foaming of Powder Particles for Structural and Functional Applications</td>
<td>Samuel Brennan, Millersville University</td>
<td></td>
</tr>
<tr>
<td>044</td>
<td>4:05 p.m.</td>
<td>Results of Experiments with Cold Spray Deposition of Fe-Based ODS Alloys Using As-Atomized Spherical GARS Powder</td>
<td>Rebecca Whitesell, Iowa State University</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Session 13</th>
<th>Time</th>
<th>USA/Country</th>
<th>Title</th>
<th>Speaker(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>104</td>
<td>3:15 p.m.</td>
<td>Microgravity Liquid-Phase Sintering</td>
<td>Randall M. German, FAPMI, German Materials Technology</td>
<td></td>
</tr>
<tr>
<td>156</td>
<td>3:40 p.m.</td>
<td>Spark Plasma Sintering of Tungsten and Lanthanated Tungsten</td>
<td>John L. Johnson, FAPMI, Emet Technologies LLC</td>
<td></td>
</tr>
<tr>
<td>049</td>
<td>4:05 p.m.</td>
<td>Manipulating Bimodal Grain-Size Distribution to Enhance Material Properties in a Spark Plasma Sintered Nanostructured FeNiZr Alloy</td>
<td>Sean Fudger, U.S. Army Research Laboratory</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Session 14</th>
<th>Time</th>
<th>Country</th>
<th>Title</th>
<th>Speaker(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>148</td>
<td>3:15 p.m.</td>
<td>Italy</td>
<td>The Analysis of the Densification Curve of Metallic Powders in Uniaxial Cold Compaction</td>
<td>Ilaria Cristofolini, University of Trento</td>
</tr>
<tr>
<td>149</td>
<td>3:40 p.m.</td>
<td>Italy</td>
<td>A Design Procedure to Define the Optimum Hardness of Parts Subject to Contact Stresses</td>
<td>Alberto Molinari, FAPMI, University of Trento</td>
</tr>
<tr>
<td>090</td>
<td>4:05 p.m.</td>
<td>USA</td>
<td>Modeling of Plasma Spray Process for Thermal Barrier Coating</td>
<td>Abhilash Gulhane, Indiana University—Purdue University Indianapolis (IUPUI)</td>
</tr>
</tbody>
</table>
**SPECIAL INTEREST PROGRAM**  
*Tuesday Afternoon  3:15–4:30 p.m.*

<table>
<thead>
<tr>
<th>Session</th>
<th>Title</th>
<th>Speaker(s)</th>
<th>Country</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>A16</td>
<td>Organic Binder-Based AM</td>
<td>Thomas F. Murphy, FAPMI, Hoeganaes Corporation</td>
<td>USA</td>
<td>3:15 p.m.</td>
</tr>
<tr>
<td>A17</td>
<td>Recycling of AM Powders II</td>
<td>Deepak Madan, Luxfer Magtech</td>
<td>United Kingdom</td>
<td>3:15 p.m.</td>
</tr>
<tr>
<td>A18</td>
<td>Effect of AM Process on Mechanical Properties</td>
<td>Jane LaGoy</td>
<td>USA</td>
<td>3:15 p.m.</td>
</tr>
</tbody>
</table>

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

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

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

<table>
<thead>
<tr>
<th>Session</th>
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<th>Speaker(s)</th>
<th>Country</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>A16</td>
<td>Additive Manufacturing of a Novel Cr-Ni Alloy Using the Bound Metal Deposition (BMD) Technique</td>
<td>Animesh Bose, FAPMI, Desktop Metal, Inc.</td>
<td>USA</td>
<td>3:15 p.m.</td>
</tr>
<tr>
<td>A17</td>
<td>Powder Re-Use Strategies for Additive Manufacturing Production</td>
<td>Lucy Grainger, Renishaw Inc.</td>
<td>United Kingdom</td>
<td>3:15 p.m.</td>
</tr>
<tr>
<td>A18</td>
<td>Robust Metal Additive Manufacturing Development and Industrialization</td>
<td>Youping Gao, Castheon, Inc.</td>
<td>USA</td>
<td>3:15 p.m.</td>
</tr>
</tbody>
</table>

**Organic Binder-Based AM**

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

**Recycling of AM Powders II**

**Session Chairman:**
- Deepak Madan, Luxfer Magtech

**Effect of AM Process on Mechanical Properties**

**Session Chairman:**
- Jane LaGoy
### POWDERMET TECHNICAL SESSIONS

#### Wednesday, June 26

#### TECHNICAL SESSIONS

**Wednesday Morning 8:00–9:15 a.m.**

<table>
<thead>
<tr>
<th>Session</th>
<th>Country</th>
<th>Time</th>
<th>Topic</th>
<th>Speaker(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SESSION 15</strong></td>
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</tr>
<tr>
<td><strong>Furnace and HIP Technology</strong></td>
<td>USA</td>
<td>8:00 a.m.</td>
<td>Introduction to Furnace Technology as It Relates to Various Powdered Metal Applications</td>
<td>Michael Hager, Verder Scientific, Inc</td>
</tr>
<tr>
<td></td>
<td>Australia</td>
<td>8:25 a.m.</td>
<td>The Evolution of Hot Isostatic Pressing for the Treatment of Radioactive Wastes</td>
<td>Salvatore (Sam) Moricca, AMEPT LLC</td>
</tr>
<tr>
<td></td>
<td>USA</td>
<td>8:50 a.m.</td>
<td>The Influence of Hot Isostatic Pressing (HIP) and Heat Treatment on the Microstructure and Properties of PBF IN718</td>
<td>Magnus Ahlfors, Quintus Technologies</td>
</tr>
<tr>
<td><strong>SESSION 16</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Refractory Materials</strong></td>
<td>USA</td>
<td>8:00 a.m.</td>
<td>Additive Manufacturing of Polymer Derived Ceramics</td>
<td>Xuehui Yang, Indiana University—Purdue University Indianapolis (IUPUI)</td>
</tr>
<tr>
<td></td>
<td>Germany</td>
<td>8:25 a.m.</td>
<td>On the Metallurgy and Manufacture of Cast Metallic Heat Resistant Alloys as Components for Powder Processing Applications</td>
<td>Shankar Venkataraman, Schmidt + Clemens Group</td>
</tr>
<tr>
<td></td>
<td>Germany</td>
<td>8:50 a.m.</td>
<td>NbC-TiC7N3 Cermets for Machining and for Wear Protection</td>
<td>Mathias Woydt, BAM Federal Institute for Materials and Testing</td>
</tr>
<tr>
<td><strong>SESSION 17</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Densification</strong></td>
<td>Canada</td>
<td>8:00 a.m.</td>
<td>For Powder Bed Additive Manufacturing Process: Correlations Between Single Layer Density and Powder Properties with the Assistance of Coherence Scanning Interferometry</td>
<td>Basel Alchikh-Sulaiman, McGill University</td>
</tr>
<tr>
<td></td>
<td>USA</td>
<td>8:25 a.m.</td>
<td>The Influence of Precursor Derived Secondary Structures on the Sintering Behavior of Binder Jet 3D Printed Titanium Dioxide</td>
<td>Lynnora Grant, Rice University</td>
</tr>
<tr>
<td></td>
<td>USA</td>
<td>8:50 a.m.</td>
<td>Loose Powder Sintering: An Overview of Densification Behavior Pore Formation of Copper and 435 Steel Powders</td>
<td>Arun K. Chattopadhyay, Uniformity Labs</td>
</tr>
</tbody>
</table>
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

**Session A19**

<table>
<thead>
<tr>
<th>114 USA</th>
<th>8:00 a.m.</th>
<th>115 USA</th>
<th>8:25 a.m.</th>
<th>036 Slovenia</th>
<th>8:50 a.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Corrosion Properties of Inconel 625 Processed by Laser Powder Bed Fusion</strong>&lt;br&gt;Sundar V. Atre, University of Louisville</td>
<td><strong>Advanced Corrosion Studies of Alloys Fabricated by Laser Powder Bed Fusion</strong>&lt;br&gt;Sundar V. Atre, University of Louisville</td>
<td><strong>Anti-Wear Properties of Direct Metal Laser Sintered Steel Parts and the Effect of Printing Direction</strong>&lt;br&gt;Bojan Podgornik, Institute of Metals and Technology</td>
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</table>

**Session A20**

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<thead>
<tr>
<th>007 USA</th>
<th>8:00 a.m.</th>
<th>167 USA</th>
<th>8:25 a.m.</th>
<th>140 USA</th>
<th>8:50 a.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Automated Particle Size and Shape Characterization of Metal Powders for Additive Manufacturing</strong>&lt;br&gt;Alan F. Rawle, Malvern Panalytical</td>
<td><strong>Effects of Powder Characteristics, Recycling, and Process Parameters on the Microstructural and Mechanical Properties of Direct Energy Deposition Ti-6Al-4V</strong>&lt;br&gt;Courtney B. Morgan, Center for Advanced Vehicular Systems (CAVS)—Mississippi State University</td>
<td><strong>SuperPower: A Computer Vision Approach to Morphological Distribution Analysis for Metal Powders</strong>&lt;br&gt;Andrew R. Kitahara, Carnegie Mellon University</td>
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</table>

**Session A21**

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<thead>
<tr>
<th>018 USA</th>
<th>8:00 a.m.</th>
<th>081-R USA</th>
<th>8:25 a.m.</th>
<th>169 USA</th>
<th>8:50 a.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dimensional Stability in Binder Jet 3D Direct Metal Printing</strong>&lt;br&gt;James W. Sears, Carpenter Technology Corporation</td>
<td><strong>Fatigue Study of 316L Produced Using Binder Jet 3D Printing with Hot Isostatic Pressing</strong>&lt;br&gt;Andrew Klein, ExOne</td>
<td><strong>A Review of Additive Manufacturing Methods for Tungsten Heavy Alloy</strong>&lt;br&gt;Michael T. Stawovy, H. C. Starck Inc.</td>
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</tr>
<tr>
<td>Session</td>
<td>Country</td>
<td>Time</td>
<td>Title</td>
<td>Presenter</td>
<td>Institution</td>
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<tr>
<td>083-R</td>
<td>USA</td>
<td>9:30 a.m.</td>
<td>Manufacturing Methods for High-Density Powdered Metal (PM) Applications and Their Effect on Mechanical Properties</td>
<td>Amber Tims</td>
<td>North American Höganäs Co.</td>
</tr>
<tr>
<td>064</td>
<td>Malaysia</td>
<td>9:55 a.m.</td>
<td>A Preliminary Process for Incorporation of Graphene Reinforcement in Copper-Based Feedstock</td>
<td>Faiz Ahmad</td>
<td>Universiti Teknologi PETRONAS (UTP)</td>
</tr>
<tr>
<td>135-R</td>
<td>USA</td>
<td>10:20 a.m.</td>
<td>Effects of Sintering Conditions on the Diffusion Bonding of AgC-Cu Electrical Contacts</td>
<td>Daudi R. Waryoba</td>
<td>The Pennsylvania State University</td>
</tr>
<tr>
<td>126</td>
<td>Switzerland</td>
<td>9:30 a.m.</td>
<td>A Revolutionary Approach to Tooling Changeover on Multi-Level Presses</td>
<td>Guillermo Polo</td>
<td>Osterwalder Inc.</td>
</tr>
<tr>
<td>005</td>
<td>USA</td>
<td>9:55 a.m.</td>
<td>Room Temperature Compaction for Higher Density in Powder Metal Parts</td>
<td>Kalathur S. Narasimhan</td>
<td>FAPMI, P2P Technologies</td>
</tr>
<tr>
<td>171</td>
<td>Germany</td>
<td>10:20 a.m.</td>
<td>Modern Automation Systems for Powder Compaction Presses</td>
<td>Nicolas Hemmer</td>
<td>KOMAGE Gellner Maschinenfabrik KG</td>
</tr>
<tr>
<td>124</td>
<td>Spain</td>
<td>9:30 a.m.</td>
<td>Methods for the Reduction of the Friction Coefficient of Sintered Bushings</td>
<td>Mark J. Dougan</td>
<td>AMES PM Tech Center</td>
</tr>
<tr>
<td>176</td>
<td>USA</td>
<td>9:55 a.m.</td>
<td>Wear Resistance and Mechanical Properties of PM Alloy Materials</td>
<td>Arthur E. Jones</td>
<td>Symmco Inc.</td>
</tr>
<tr>
<td>187-R</td>
<td>USA</td>
<td>10:20 a.m.</td>
<td>High-Strength Aluminum-Zinc Composite PM Grade with Trace Amount of Copper for Powder Metallurgy Applications</td>
<td>Jessu Joys</td>
<td>United States Metal Powders, Inc.</td>
</tr>
</tbody>
</table>
### SPECIAL INTEREST PROGRAM

**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
- William 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.

<table>
<thead>
<tr>
<th>Session A22</th>
<th>Session A23</th>
<th>Session A24</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AM Powder Flow Characterization</strong>&lt;br&gt;Session Chairman: Chaman Lall, MPP</td>
<td><strong>Design of Metal AM Structures</strong>&lt;br&gt;Session Chairman: Howard Kuhn, University of Pittsburgh</td>
<td><strong>Copper-Based AM</strong>&lt;br&gt;Session Chairman: Richard Mason, Mason Global Materials</td>
</tr>
<tr>
<td>100 Canada 9:30 a.m. <strong>Understanding the Factors Influencing Powder Spreadability for Laser Powder Bed Fusion</strong>&lt;br&gt;Eileen Ross L. Espiritu, McGill University</td>
<td>029 United Kingdom 9:30 a.m. <strong>Multifunctional Lattices by Additive Manufacturing</strong>&lt;br&gt;Daniel Barba, University of Oxford</td>
<td>089 USA 9:30 a.m. <strong>Effect of Solids Loading, and Volumetric Flow Rate on Properties of Metal-Fused Filament Fabricated (MF3) Bronze</strong>&lt;br&gt;Paramjot Singh, University of Louisville</td>
</tr>
<tr>
<td>060 Canada 9:55 a.m. <strong>Powder Flowability and Density: Effect of Humidity and Impact on the Reproducibility of the Measurements</strong>&lt;br&gt;Louis-Philippe Lefebvre, National Research Council Canada</td>
<td>020 United Kingdom 9:55 a.m. <strong>Application of Lattice Structures for Convective Heat Transfer</strong>&lt;br&gt;Sam Catchpole-Smith, University of Nottingham</td>
<td>178 Germany 9:55 a.m. <strong>Raising Copper Parts in Size-Enabling Advanced Space Applications</strong>&lt;br&gt;Martin Bullemer, AMCM GmbH</td>
</tr>
<tr>
<td>180 USA 9:30 a.m. <strong>Overview of Industrial Data Collection Systems</strong>&lt;br&gt;Larry Shindledecker, Gasbarre Products, Inc.</td>
<td>190 USA 9:55 a.m. <strong>I Have Data! Now What?</strong>&lt;br&gt;Jeffrey F. Chileski, Abbott Furnace Company</td>
<td><strong>No presentation scheduled at this time.</strong></td>
</tr>
<tr>
<td>179 USA 9:55 a.m. <strong>Correlation Between the Flowability of Ti-6Al-4V Powders Used in the Laser Powder Bed Fusion Process and the Process Performances</strong>&lt;br&gt;Salah Eddine Brika, Université du Québec</td>
<td><strong>Smart Sensors</strong>&lt;br&gt;J.J. Thiara, Rockwell Automation</td>
<td></td>
</tr>
<tr>
<td>102 Spain 10:20 a.m. <strong>On the Size-Dependent Strength of Additive Manufactured Titanium</strong>&lt;br&gt;Carles Alabort, Polytechnic University of Valencia</td>
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</table>

### AMPM TECHNICAL SESSIONS

**Wednesday Morning 9:30–10:45 a.m.**

**SESSION A22**

**AM Powder Flow Characterization**<br>Session Chairman: Chaman Lall, MPP

100 Canada 9:30 a.m. **Understanding the Factors Influencing Powder Spreadability for Laser Powder Bed Fusion**<br>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**<br>Louis-Philippe Lefebvre, National Research Council Canada

**SESSION A23**

**Design of Metal AM Structures**<br>Session Chairman: Howard Kuhn, University of Pittsburgh

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

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

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

**SESSION A24**

**Copper-Based AM**<br>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**<br>Paramjot Singh, University of Louisville

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

**No presentation scheduled at this time.**
### Wednesday, June 26

#### TECHNICAL SESSIONS

<table>
<thead>
<tr>
<th>Session</th>
<th>Time</th>
<th>Title</th>
<th>Speaker(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SESSION 21</strong></td>
<td><strong>Powder Test and Evaluation</strong></td>
<td>11:00 a.m. 3D Digital Image Correlation: The Ultimate Tool for Displacements and Strains Testing</td>
<td>Charles-Olivier Amyot, Trilion Quality Systems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11:50 a.m. Using Powder Rheology Measurements to Optimize the Mixing Time of an Iron-Based Premix for Best Die-Filling Performance</td>
<td>Boris Nijikovsky, Université du Québec</td>
</tr>
</tbody>
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<thead>
<tr>
<th>Session</th>
<th>Time</th>
<th>Title</th>
<th>Speaker(s)</th>
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</thead>
<tbody>
<tr>
<td><strong>SESSION 22</strong></td>
<td><strong>Secondary Operations</strong></td>
<td>11:00 a.m. Effect of Hybrid Post-Sinter Treatment on Sinter Hardened (SH) Structural Parts from PM Steels</td>
<td>Leonid I. Frayman, Allegheny Coatings/Pamlico Coatings Group</td>
</tr>
<tr>
<td></td>
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<td>11:25 a.m. Effect of Carbon Content on the Machinability of Powdered Metal Copper Steels</td>
<td>Cody Kalinoski, Engineered Sintered Components</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11:50 a.m. Study on Corrosion Performance and Microstructure of Sinter Hardened Artifacts Subjected to Various Finishing</td>
<td>Leonid I. Frayman, Allegheny Coatings/Pamlico Coatings Group</td>
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</tbody>
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<th>Title</th>
<th>Speaker(s)</th>
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<tbody>
<tr>
<td><strong>SESSION 23</strong></td>
<td><strong>Safety and Management</strong></td>
<td>11:00 a.m. Contaminated Cartridge-Type Dust Collectors May Pose Serious Health and Environmental Risks</td>
<td>Michael W. Seitz, BlueSky Global</td>
</tr>
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<td></td>
<td></td>
<td>11:25 a.m. Metal Powder Recycling—Closing the Loop on Sustainability</td>
<td>Josh Lifshitz, Globe Metal</td>
</tr>
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<td></td>
<td></td>
<td>11:50 a.m. Talent Acquisition, Utilization and Retention in the PM Industry...</td>
<td>Rocco Petrilli, PKPM Advisory Group</td>
</tr>
</tbody>
</table>

**POWDERMET TECHNICAL SESSIONS** | **Wednesday Morning** | **11:00 a.m.–12:15 p.m.**
### 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  
  William 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

<table>
<thead>
<tr>
<th>Session</th>
<th>Country</th>
<th>Time</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>188</td>
<td>USA</td>
<td>11:00 a.m.</td>
<td>A Platform for Data Science Applications to Industrial Processes—Part I</td>
<td>Dilsat Dalkiran, SAP America</td>
</tr>
<tr>
<td>202</td>
<td>USA</td>
<td>11:25 a.m.</td>
<td>A Platform for Data Science Applications to Industrial Processes—Part II</td>
<td>Dilsat Dalkiran, SAP America</td>
</tr>
<tr>
<td>205</td>
<td>USA</td>
<td>11:50 a.m.</td>
<td>Industry 4.0 and Big Data: The Signal and the Noise</td>
<td>Steven R. Schmid, University of Notre Dame</td>
</tr>
</tbody>
</table>

### 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

<table>
<thead>
<tr>
<th>Session</th>
<th>Country</th>
<th>Time</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>034</td>
<td>USA</td>
<td>11:00 a.m.</td>
<td>Binder-Jet 3D Direct Metal Printing of Cobalt Chrome Moly Alloy</td>
<td>James W. Sears, Carpenter Technology Corporation</td>
</tr>
<tr>
<td>056</td>
<td>USA</td>
<td>11:25 a.m.</td>
<td>Simulations of the Stress Field Around a Sinter-Crack</td>
<td>Reid Carazzone, Rice University</td>
</tr>
<tr>
<td>037</td>
<td>USA</td>
<td>11:50 a.m.</td>
<td>Evaluation of AM Technologies in MIM Applications</td>
<td>Joseph T. Strauss, FAPMI, HJE Company, Inc.</td>
</tr>
</tbody>
</table>

#### SESSION A26

**Metal AM Post Processing**

- **Session Chairman:** Chad Spore, John Deere

<table>
<thead>
<tr>
<th>Session</th>
<th>Country</th>
<th>Time</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>107</td>
<td>USA</td>
<td>11:00 a.m.</td>
<td>Machining of Metal AM Parts in an Industry 4.0 Environment—Design, Process Control and Inspection Techniques</td>
<td>Dan Skulan, Renishaw Inc.</td>
</tr>
<tr>
<td>079</td>
<td>USA</td>
<td>11:25 a.m.</td>
<td>The Influence of Hot Isostatic Pressing (HIP) and Heat Treatment on the Microstructure and Properties of PBF IN718</td>
<td>Magnus Ahlfors, Quintus Technologies</td>
</tr>
<tr>
<td>109</td>
<td>USA</td>
<td>11:50 a.m.</td>
<td>Changing the Additive Manufacturing Industry with New, Efficient Furnace Technology</td>
<td>Janusz Kowalewski, Ipsen</td>
</tr>
</tbody>
</table>
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.

“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 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. Longpré, 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
Bartłomiej 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 Alchik-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)

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
• Meal functions: Opening Night Reception, Industry Luncheon, the PM Design Excellence Award Luncheon, and the PM Evening Alehouse*
• Registration bag with handout materials
• Post-conference digital proceedings for POWDERMET2019 and AMPM2019 technical manuscripts

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 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.

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
• Meal functions: Opening Night Reception, Industry Luncheon, the PM Design Excellence Award Luncheon, and the PM Evening Alehouse*
• Registration bag with handout materials
• Post-conference digital proceedings for POWDERMET2019 and AMPM2019 technical manuscripts

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

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

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

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...
<table>
<thead>
<tr>
<th>Event Description</th>
<th>Advance Paid by May 10</th>
<th>After May 10</th>
<th>On-Site Registration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FULL CONFERENCE REGISTRATION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(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)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MPIF-MEMBER COMPANY EMPLOYEES</td>
<td>$1,600</td>
<td>$1,700</td>
<td>$1,850</td>
</tr>
<tr>
<td>MPIF-Member (Speakers/Session Chairmen)</td>
<td>1,500</td>
<td>1,700</td>
<td>1,850</td>
</tr>
<tr>
<td>APMI Member</td>
<td>1,700</td>
<td>1,800</td>
<td>1,950</td>
</tr>
<tr>
<td>APMI Member (Speakers/Session Chairmen)</td>
<td>1,600</td>
<td>1,800</td>
<td>1,950</td>
</tr>
<tr>
<td>Non-Member</td>
<td>2,000</td>
<td>2,100</td>
<td>2,250</td>
</tr>
<tr>
<td>Non-Member (Speakers/Session Chairmen)</td>
<td>1,900</td>
<td>2,100</td>
<td>2,250</td>
</tr>
<tr>
<td><strong>NEW! Metal AM Tutorial (Optional)</strong></td>
<td></td>
<td></td>
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<tr>
<td>Explore the opportunities associated with developing a metal AM manufacturing facility.</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>EXHIBITOR REGISTRATION</strong> (for exhibitor booth staff)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Exhibitor Package 1</td>
<td>$875</td>
<td>$900</td>
<td>$925</td>
</tr>
<tr>
<td>(Opening Night Reception, PM Evening Alehouse, Opening General Session, two technical sessions, two luncheons, Closing Event, and registration bag w/ handouts)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Exhibitor Package 2</td>
<td>375</td>
<td>400</td>
<td>425</td>
</tr>
<tr>
<td>(Opening General Session, PM Evening Alehouse, two technical sessions, two luncheons, and registration bag w/ handouts)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>► Opening Reception and Closing Event purchased separately.</td>
<td></td>
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<tr>
<td>Spouse Registration</td>
<td>500</td>
<td>525</td>
<td>550</td>
</tr>
<tr>
<td>(Includes Opening Night Reception, PM Evening Alehouse and Closing Event)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student Registration</td>
<td>200</td>
<td>250</td>
<td>300</td>
</tr>
<tr>
<td>(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)</td>
<td></td>
<td></td>
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<tr>
<td>► Opening Reception and Closing Event purchased separately.</td>
<td></td>
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<tr>
<td>Daily Registration</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>(Includes technical sessions and exhibit only, plus registration bag with handouts.)</td>
<td></td>
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<tr>
<td>► Purchase meals or proceedings separately.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monday</td>
<td>$850</td>
<td>$900</td>
<td>$950</td>
</tr>
<tr>
<td>Tuesday</td>
<td>850</td>
<td>900</td>
<td>950</td>
</tr>
<tr>
<td>Wednesday</td>
<td>850</td>
<td>900</td>
<td>950</td>
</tr>
<tr>
<td>Exhibit-Only Admission</td>
<td></td>
<td></td>
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<tr>
<td>Free to qualified PM parts manufacturers only (contact MPIF for details). Exhibit is included with full or daily packages above.</td>
<td></td>
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</tr>
<tr>
<td><strong>POWDERMET2019 or AMPM2019 Digital Conference Proceedings</strong></td>
<td>$750</td>
<td>$750</td>
<td>$750</td>
</tr>
<tr>
<td>(Included with full-conference and student registration, cost for additional copies)</td>
<td></td>
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<tr>
<td><strong>Meal Tickets</strong></td>
<td></td>
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<tr>
<td>(Meals are available only to full conference registrants, spouses, students, and exhibitor personnel)</td>
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<tr>
<td>Sunday: Opening Night Reception</td>
<td>$150</td>
<td>$160</td>
<td>$175</td>
</tr>
<tr>
<td>Monday: PM Design Excellence Awards Luncheon</td>
<td>80</td>
<td>85</td>
<td>95</td>
</tr>
<tr>
<td>Tuesday: Industry Luncheon</td>
<td>80</td>
<td>85</td>
<td>95</td>
</tr>
<tr>
<td>Tuesday: Closing Event—Rhinestone Rodeo!</td>
<td>375</td>
<td>385</td>
<td>400</td>
</tr>
<tr>
<td><strong>APMI Golf Tournament (Sunday)</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Tournament Fee</td>
<td>$140</td>
<td>$140</td>
<td>–</td>
</tr>
<tr>
<td>Club Rental</td>
<td>50</td>
<td>50</td>
<td>–</td>
</tr>
</tbody>
</table>

**REGISTER AND RESERVE HOTEL ONLINE AT POWDERMET2019.ORG or AMPM2019.ORG**
The potential of powder metallurgy is only limited by one’s imagination…

GKN Hoeganaes is a world leader in the development and production of metal powders.

Over 65 years, our commitment to innovative technologies spans critical applications from Automotive to Additive Manufacturing.

GKN Hoeganaes has expanded our global footprint to meet our customers’ needs, with powder production facilities in North America, Europe and Asia.