

A Materials Technology Institute Publication



CONNECT

2023, ISSUE 1

GLOBAL CHALLENGES / TRUSTED SOLUTIONS

Responding to Industry Demand

MTI Developing High Purity
Learning Session

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CONNECT

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ABOUT THIS PUBLICATION:

MTI CONNECT is published by the Materials Technology Institute, Inc. (MTI). MTI is a unique, cooperative research and development organization representing private industry. Its objective is to conduct generic, non-proprietary studies of a practical nature on the selection, design, fabrication, testing, inspection, and performance of materials and equipment used in the process industries.

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CALENDAR OF EVENTS:

Dual Laminate & FRP Training

May 7-10, 2023
Jubail, Saudi Arabia

EuroTAC Spring Meeting

May 10-12, 2023
Munich, Germany

AmeriTAC 141

June 20-22, 2023
Milwaukee, WI

Global TAC Meeting

September 6-7, 2023
9 AM - 12 PM EDT each day
Virtual



TECHNICAL KNOWLEDGE AT YOUR FINGERTIPS

TAKING A LOOK BACK AT MTI RESOURCES FROM THE ARCHIVES

Members of MTI have access to a treasure trove of technical information 24/7 with select content available to the public. To promote knowledge transfer and provide more learning opportunities, MTI CONNECT is highlighting past resources, including publications, webinars, technical bulletins and training, to help new and long-time members alike discover the reliable collection of MTI research and take advantage of these valuable membership benefits.

FEATURED PUBLICATION

Materials Selection for the Chemical Process Industries, Second Edition

The second edition of this book, authored by C.P. Dillon (MTI Fellow) and published in 2004, is intended for professional corrosion, materials, and design, operations, or maintenance engineers concerned with process industry plants (e.g., chemical, petrochemical, or fertilizer). It provides suggestions for materials selection for the processes described, warnings about pitfalls associated with specific chemicals or mixtures of chemicals, and measures suggested to cope with specific problems associated with process industry corrosion. The second edition has been organized into four sections: Materials Selection, Heavy Chemicals, Inorganic Processes, and Organic Syntheses.

How to Access: Members can download an electronic copy from the Technical Resource Library as a benefit of membership, or copies are available for purchase in the MTI bookstore.

Member Price: \$55.00

Public Price: \$154.00

FEATURED TECHNICAL BULLETIN

Focus on Stress Corrosion Cracking

Unexpected or premature failure of chemical process equipment constitutes a serious hazard in terms of safety of personnel, operating facilities, and the environment. By weakening reliability, such failures also adversely affect productivity and profitability. Modern industrial experience in chemical plants has been that failures due to environmental cracking are among the most serious of such problems, making up about 20-30% of all corrosion failures. The subject of stress corrosion cracking (SCC) is extensive, and the focus of this issue is to discuss in simple terms some of the pertinent information.

How to Access: Technical Bulletins are available to members in the Technical Resource Library as a benefit of Membership. These documents are fully editable for purposes of distributing necessary information within your company. Visitors may download a PDF copy from the main MTI website.

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FEATURED WEBINAR ON-DEMAND

Fitness for Service Determination of Polymer-based Materials

Presented and recorded on September 24, 2018, polymers expert Pradip Khaladkar, PE, MTI Fellow, instructed MTI's inaugural webinar. The webinar includes the basic concepts of Fitness for Service and how they are applied to polymer-based materials. The concepts are illustrated by a few case histories.

How to Access: Webinars on-demand are available on the MTI website to access as a benefit of membership at any time and are often used by members for PE credits. Visitors may also access webinars on-demand for a fee of \$25 each.

INTERESTED IN MATERIALS SELECTION?

Explore MTI's MS-Series of books on materials selection for corrosion in specific processes:

MS-1	Sulfuric Acid, 2nd Edition
MS-2	Formic, Acetic and Other Organic Acids
MS-3	Hydrochloric Acid, Hydrogen Chloride, Chlorine, and Chlorine Dioxide, 2nd Edition
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MS-5	Nitric Acid
MS-6	Ammonia and Caustic Soda
MS-7	Phosphoric Acid
MS-8	Organic Solvents

The entire series is available to members in the Technical Resource Library. Each book is also available to purchase from the MTI bookstore, except MS-2. Visit www.mti-global.org and navigate to Resources to learn more.

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HOW SHIFTING PERSPECTIVE CAN IMPROVE CUI PROGRAM EFFICIENCY

APPLYING A STATISTICAL METHOD FOR INSPECTION

BY R. BRANDEN STUCKY, CORRSOLUTIONS TEAM LEADER, SENIOR ENGINEER I

Every year it feels like a new standard, a new recommended practice, a new internal initiative comes around and must be executed by the boots on the ground. We know that Corrosion Under Insulation (CUI) is one of our worst actors, and if we could devote time and effort to it, we are pretty sure we could make a difference. Unfortunately, we have a plethora of initiatives we shall comply to, meaning we can't focus on CUI as much as we would like to. Now this isn't all bad, we need to have a well-rounded mechanical integrity program covering a broad range of programs, but if we could just spend a little more time on the ones we really know are troubling, we might feel like we are making a dent in discovering issues proactively.

A Shift in Strategy

Typically, compliance requirements, and internal processes cause

owner-operators to manage a multitude of mechanical integrity and reliability programs. With so many programs, a shift in conventional strategy could provide some additional benefits, specifically to internal corrosion. Many in the petrochemical industry acknowledge that internal corrosion is not a very prevalent damage mechanism; however, maintenance teams are still required to inspect for corrosion. Unfortunately, this effort becomes one of the largest expenses within an inspection group and one of the most labor-intensive tasks. If plants can implement a system to control the internal corrosion program, it would be possible to focus inspection efforts onto programs like CUI.

How can plants use the codes and standards to its advantage to achieve confidence in a thickness management program and focus on CUI? The first step is understanding the current data. At many plants, an Inspection Data Management System (IDMS) is filled with thickness readings that may or may not be useful. Often maintenance personnel have corrosion

> CONTINUED ON PAGE 22



HATCH BRINGS UNIQUE MATERIALS ENGINEERING EXPERTISE TO MTI

DESCRIBES INSTANT VALUE AND OPPORTUNITIES OF MEMBERSHIP

Before Murray Pearson, Director, Technology Development, Pressure Hydrometallurgy Practice, ever attended an MTI Meeting, he was intrigued. "I was approached by two members, Chuck Young from Tricor, and Matthew Thayer, who at the time worked for Koch Knight, which is now Knight Material Technologies," he recalls. "They said, there's this group that we think you would really benefit from being members, and we're pretty sure that you would find what they're doing interesting as well." Pearson was invited to attend AmeriTAC 130 in Corpus Christi, Texas, and saw the many possibilities for his company after just a few days of project team meetings, presentations, and technical discussions. He was hooked on the multiple JIPs concept.

Although the pandemic paused his plans to join in 2020, Pearson persevered and finally received senior management's approval for membership in 2022. Now Hatch is one of MTI's newest and increasingly engaged members, with a lot to offer the organization in terms of materials engineering expertise.

The Toronto-based firm, which started in 1965 by providing consulting engineering services for the iron and steel industry and underground tunnelling, has grown into one of the world's leading engineering and consulting firms serving the mining and metals, energy, and infrastructure sectors. Today Hatch works on projects around the world. "We're working from 60 offices, and on almost every continent, except Antarctica," laughs Pearson.

On the "contributions" side of the membership ledger, Pearson points out Hatch brings more than

HATCH

65 years' experience employing both metallic and non-metallic materials in very aggressive environments, like high temperature furnaces and converters in smelters. "Then, in the last 25 years, projects involving hydrometallurgical applications where we're dealing with strong oxidizers, strong acids, strong caustics or alkaline processes," he adds. "So we have quite a bit of experience in the selection and specification of materials for those different applications. Plus, over the years, we've also developed protocols for testing and qualification of new materials for different applications. I think those are probably the two things that we can bring to the organization that people will find useful."

Hatch is also exploring the possibility of attracting producer members from new market sectors. "We would like to develop a cluster of new members from the mining and metallurgical community, starting with some of our more forward-thinking clients that are developing new processes and new ways of processing concentrates," he shares.

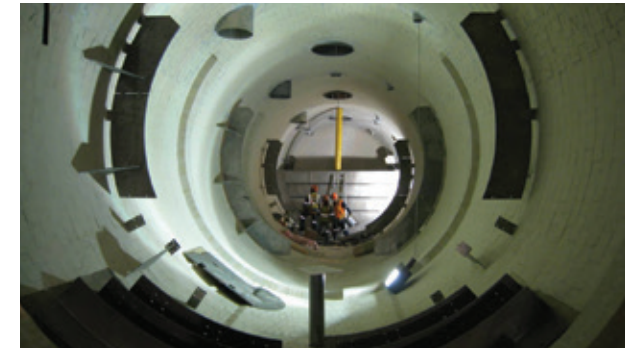
As far as benefitting from membership, Pearson hopes to see more and more Hatch employees take advantage of the education and training materials that are on MTI's website and the workshops and seminars that MTI sponsors at nearly every TAC meeting. "I think there's an enormous opportunity there for

both young and old engineers in our company to learn about the proper application of materials in the various applications that we're up against," he says. "I think it'll be useful for them to participate in the organization more."

"The second thing is, I think we're already benefiting from just our participation in the TAC meetings, particularly the last two that I've attended, where we're discussing the future applications of materials in the lithium and battery chemicals field."

MTI's potential project on the selection and corrosion performance of various alloys in lithium brine services is also on Pearson's radar. "We've got a number of projects in that space, both in processing of Spodumene, which is one of the lithium containing minerals, as well as extracting light metals including lithium and that [alkali metals] Group from hydro-geothermal brines," he explains. "We think there is a direct application there to at least two projects that we're currently working on, so we're definitely taking an interest in that one."

Pearson sees plenty of opportunity for cross pollination of solutions, based on working with MTI supplier members to solve Mining Industry problems. "In the chemical industry in particular, we think that there are some shared experiences and challenges, particularly in the production and recovery and recycling of



Hatch's signature gold project, Pueblo Viejo, located in the Dominican Republic is designed to process 24,000 t/d of refractory ore through four autoclave circuits with an average gold production of 1.125 million ounces per annum.

Top Left: The pressure oxidation facility, including the autoclave building and high bay.

Top Right: Installation of Titanium compartment walls and baffles inside a refractory lined autoclave.

Bottom: One of four pressure oxidation autoclave circuits. Each vessel is 5.6 m ID X 37.6 m overall length and is equipped with seven agitators designed to disperse high purity oxygen into a continuous feed of refractory sulphide slurry.

reagents, like acids, for example," he points out. "One that comes to mind is what we call pyrohydrolysis [for regeneration] and recovery of hydrochloric acid. I noticed that a number of members have challenges in that area, and we also have worked a lot with oxygen, and high-pressure oxygen systems. Our furnace teams work with high temperature alloys, [such as] high nickel, creep resistant alloys, for high temperature [$>1500^{\circ}\text{C}$] furnaces. We think that there may be some opportu-

nity to share some experience and knowledge there with people that are designing and operating steam methane reformers, which we talked about in our last meeting. So I think there are a few examples where some of the members from the Chemical Process Industry would be interested in what our experience is, and vice versa."

Despite being a member for less than a year, Pearson is already a fan and wearing his MTI hat. "One thing I would like to say is how impressed

I am with not only the organization, but the quality of its members and the content of the presentations and the various projects that have been developed," he says. "It's a very forward-looking organization with a lot of valuable history, and I hope that will continue for many decades to come. We're excited to be members of the organization!" MTI welcomes Hatch to its worldwide technical community. ■

ASIATAC REPORT

SPRING MEETING PREVIEW AND NICKEL ALLOYS CORROSION DATA PROJECT



The AsiaTAC Spring Meeting will be held in Da Nang, Vietnam, an unexplored area for the group but selected due to its fast-growing economy.

The first quarter of 2023 was a busy one for MTI's AsiaTAC Leadership Team, as it juggled preparations for its first-ever meeting in Vietnam and completing the final stages of Project 367, Corrosion Data Collection, Nickel Alloy, phase II.

The last three AsiaTAC meetings were in-person only for members located near Shanghai, China, according to Tzu-Ping Cheng (ITRI), AsiaTAC Chair. "The Steering Team sensed the necessity to host an in-person meeting as early as possible," he reports. As such, the committee decided to organize the AsiaTAC Spring meeting as an international event in Da Nang, Vietnam, April 19-20. "All members from Asia, the Middle East, Europe, and North America are welcome to attend," says Cheng.

"Why did we choose this region? The reason is simple. The Asian economy is growing fast, especially Vietnam's in recent years. The third refinery in the south of the country, a symbol of the growing economy, is planned to meet domestic demand. It is a good time for MTI

to step into this unexplored region and introduce the MTI mission."

Day one of the meeting will begin with an "Introduction to MTI" by Heather Allain, MTI Executive Director, followed by "MTI as a Materials Engineering Knowledge Resource" presented by Kirk Richardson, MTI Marketing Director. Gary Coates, Technical Director of the Nickel Institute, will then share "Highlights of MTI Ongoing and Completed Projects."

Next on the agenda, Mai Tuan Dat, Director of Dung Quat Oil Refinery Plant and Deputy Director of Binh Son Refining and Petrochemical Joint Stock Company, will provide a special lecture on "Corrosion Status at Dung Quat Oil Refinery Plan." Coates will then conclude the morning session with a presentation on "Quality Sources of Information to Assist in Selection of Materials for Industrial Applications."

A full slate of presentations will run from the afternoon into the early evening, including:

- A New PRE 52 Alloy for Corrosive Environments, Dragon Hao (Alleima)

- Cases of Stainless Steels in Chemical Industries, Jan Li (Outokumpu)
- Role of Metallurgical Aspects on Mechanical Failure of Superduplex Stainless Steel Tubing, Ekkarut Viyanit (NSTDA)
- Understand and Minimize Flange Face Corrosion During Plant Construction, Le Thi Hong Lien (IMS)
- Failure of DSS 2205 REAC in a Refinery Hydroprocessing Unit – A Case Study, Tzu-Ping Cheng (ITRI)
- Repair the Riser Pipe of Waste Heat Boiler, Le Hoang Viet (Ca Mau Fertilizer Plant)
- Failure Analysis for Bearing Housing Welds of Cooling Water Pump System, Cheng-Yang Tsai (ITRI)
- New Alloy for Metal Dusting Application, Dior Chen (Haynes International)
- Sharing Practices to Manage the Low Flow Problem in Heat Exchangers, Pongpat Lortrakul (SCG REPCO)

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EUROTAC TO DISCUSS USE RESTRICTION OF PFAS MATERIALS

SPRING 2023 MEETING PREVIEW AND REGISTRATION

It's been a busy time at EuroTAC, especially following the success of the Fall 2022 meeting and Dual Laminate & FRP Course held in Amsterdam. Now the leadership team has prepared another excellent meeting for Spring 2023, which will be held May 10-12. It will take place in Munich, Germany, and is generously being hosted by Linde PLC Engineering Division at their location in the modern AGORA center in Pullach just southwest of Munich. The technical session will kick off at 1:00 PM on May 10. A full day follows on May 11, with a special dinner event planned that evening at the Restaurant "Museumsstüberl" in Munich. The meeting will conclude on Friday, May 12 with a farewell lunch.

As is typical for EuroTAC, the upcoming meeting will focus heavily on projects. The agenda consists of multiple status updates of existing projects, an extensive project development committee session aimed at developing new project proposals, updates of AmeriTAC and

AsiaTAC projects, new project ideas and initiatives, and presentations by experts on technical topics of interest to the EuroTAC community.

One topic of high interest and slated for discussion at EuroTAC is the proposal for use restriction of PFAS materials recently released by the European Chemicals Agency. This restriction would impact the use of many fluoropolymer materials in plant applications. The session will facilitate participant discussions related to potential consequences and alternatives.

Other confirmed presentations include:

- Impact of the Gas Composition on Ni-based and NiCu Alloys in Metal Dusting Conditions, Dr. Matthias Galetz et al. (DECHEMA FFM)
- Additive Manufacturing: The Role of Inert-Gases in the 3D Printing Process; potential Use Cases in Plant Design,

Dr. Matthias Grundwürmer et.al. (Linde Engineering)

- Modern Design of Tubes & Flange Connections: The Groove System relevant to the CPI / Oil & Gas and Fire Extinguishing Systems, Guillaume Chounet (Victaulic).

Scan the QR code or visit www.mti-global.org for additional information and registration. A very informative and productive meeting is anticipated—EuroTAC participants won't want to miss this, so be sure to register and attend! ■



AMERITAC UPDATE

TAC 140 RECAP, PLANS FOR HIGH PURITY LEARNING AND EXCHANGE SESSION IN JUNE

AmeriTAC 140, held February 20-22, 2023, in Ft. Lauderdale, Fla., was packed with technical information, projects and networking. TAC Chair, Andrew Rentsch (Huntsman) and Vice Chair, David Cole (Eastman Chemical), developed a roundtable with key speakers focused on Corrosion Challenges of Molecular Recycling. The half-day roundtable kicked-off the event, which then led to the next two days of project updates and discussion, project development meetings, and dedicated technical presentations on “Mothballing of Plants for Extended Outages” by Tony Scribner (Becht) and “Surgical Micro Laser Welding Repairs on Otherwise Un-weldable Components” by Blair Learn (Alpha Laser).

Eleven current MTI projects teams met, two projects were proposed for funding, and two new projects formed (page 11). The two new projects included: #399 – Second Dual Laminate Training for the US, championed by Lisa Desai (Pfaudler) and Avery Boyer (Chemours); and #400 – Ceramics Refresh Training, championed by Jay Schickling (Chemours).

Since the conclusion of the first 2023 AmeriTAC meeting, the

leadership duo has actively focused on developing a High Purity learning and exchange session for the upcoming June meeting to educate, innovate, and tackle industry challenges within this space. The increasing consumer demand for smaller, denser electronic devices has come with a push for higher purity raw materials. Semiconductor and battery manufacturing must now apply stricter purity controls on chemicals and gases used throughout their entire operations. MTI membership, consisting of large-scale chemical producers, refiners, material suppliers, fabricators, and materials experts, are facing these issues and other questions:

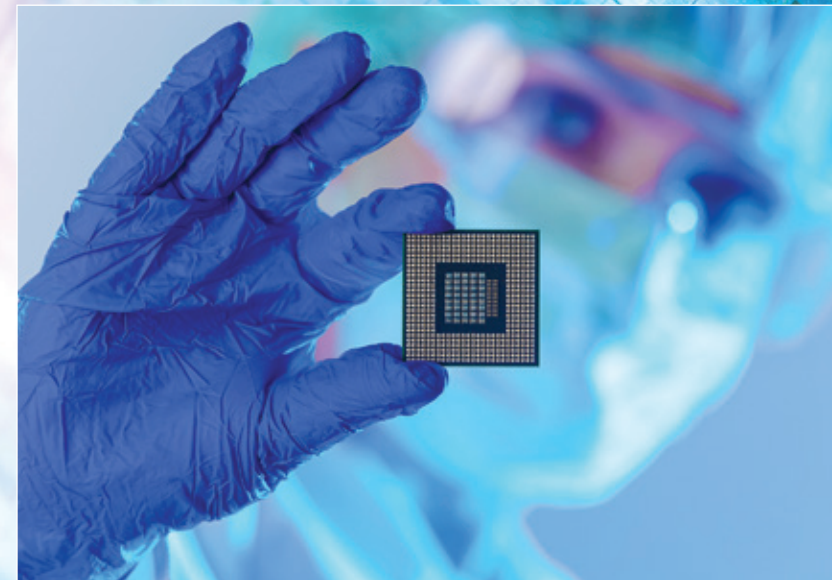
- What changes within a chemical production facility are required to meet part per trillion impurity levels?
- How does the materials selection of process equipment and surface treatments impact achievable quality levels?
- How can impurities be reliably detected, quantified, and eliminated?

This one-day program will feature a series of presentations and roundtable discussions on the challenges with materials handling, design,

fabrication, inspection, and maintenance of equipment processing high purity products. Discussions will also include how to apply SEMI & ASME BPE standards, and how to best evaluate alternative materials (liners, O-rings, seals) when presented with supply chain challenges.

Different from past June meetings, which typically start on Monday, the hot button session will begin on Tuesday, June 20 and the TAC meeting will conclude on Thursday, June 22. In addition to the usual technical content and project schedule, the team is working to secure a networking reception and conclusion dinner off-site with the option of many restaurants and venues in the downtown Milwaukee area. There will also be an opportunity to purchase tickets at registration to a Milwaukee Brewers baseball game on the evening of June 19 prior to the meeting for anyone interested.

Registration and hotel information will be available in mid to late April. For details and developments on the upcoming meeting, including presentations and speakers as they are confirmed, please visit www.mti-global.org/about/events/ameritac-meeting. ■



The increasing consumer demand for smaller, denser electronic devices has come with a push for higher purity raw materials. Semiconductor and battery manufacturing must now apply stricter purity controls on chemicals and gases used throughout their entire operations.



The Molecular Recycling Roundtable at AmeriTAC 140 concluded with a Q&A session where speakers addressed questions that came up throughout the event.



Attendees of AmeriTAC 140 enjoy an ice cream break and networking in Ft. Lauderdale, FL.

TWO PROJECTS FUNDED AT AMERITAC 140

These projects, approved by TAC based on technical merit, were presented to the MTI Board of Directors (BOD) for funding approval. The BOD voted on February 23, 2023, to approve the requested funding amounts.

#310 – New Test Method for Titanium Hydriding



Scope: Inspect a heat exchanger (at a facility volunteered by a member) that is believed to be failing due to Ti Hydriding.

Champion: Curtis Huddle, Eastman Chemical

Funded: \$12,000


#385 – MTI Podcast



Scope: An aging workforce presents an economic impact to companies that lose knowledge. Maintaining and transferring this knowledge is crucial to limit interruptions to business operations. MTI has a vast repository of knowledge both in the MTI library and among its members. The MTI podcast will aid in capturing knowledge that is not currently recorded as well as improve accessibility to existing knowledge through distribution as an audio format. This project focuses on the establishment of the podcast after which it will be moved into an ongoing committee.

Champion: Marc Cook, Dow

Funded: \$23,500



ONE-STEP METHOD PRODUCES **Robust Superhydrophobic Surfaces**

VICTORIA GRANJA & C. FRED HIGGS III – RICE UNIVERSITY

**Potential Application
for Polymers to Reduce
Permeation of Water**

Robust Superhydrophobic Surfaces

Engineered surfaces with extreme wetting properties have gained increased attention because of their wide range of applications from microfluidic devices to macroscale smart coatings¹. Superhydrophobic surfaces, in particular, have garnered sustained interest because of their extensive applications in the fields of self-cleaning, anti-icing and drag reduction systems. However, previous research usually involves complex fabrication strategies to modify the surface wettability. Additionally, traditional micro-to-nano fractal structures and organic coatings are fragile, susceptible to wear, and decay over time, resulting in inevitable exposure of subsurface regions and rapid degradation of the intrinsic wetting properties.

Some strategies, such as chemical grafting with stronger covalent bonds, fabricating armored hierarchical structures or nanocomposite coatings, and the addition of a sacrificial top layer, had been developed to increase the robustness of the superhydrophobic samples in terms of mechanical and temporal stability. However, these techniques either fall short of achieving mechanical and time-dependent stability or involve complex and specialized fabrication procedures, which slows down their commercialization.

Here, a one-step sand-in method is proposed, to produce superhydrophobic coating layers directly atop various substrates with distinct initial wettability². The resulting surfaces exhibit an apparent contact angle (CA) up to ~163.8° and hysteresis <5° with enhanced temporal and mechanical stability. The superhydrophobic surfaces are shown to be stable after 18 months of storage in a humid environment and can withstand 100 Scotch tape-peeling tests. The surface wettability can be adjusted to range from being hydrophilic to superhydrophobic by modifying the sand-in conditions and powder additives, which expands the spectrum of possible applications for the sand-in process.

Sand-In Strategy to Build Robust Modified Surfaces

A typical sand-in method (Figure 1) entails sanding the substrates for ~1 min by vitrified abrasants (sandpaper) to introduce surface roughness, followed by depositing powder atop the substrates and sanding the substrates again for ~3 min. The sanded-in surface is then cleared of any extra powder. This process is repeated twice

with newly added powder to guarantee homogeneity. To disrupt heterogeneity, care must be taken to change sanding direction often. Sanding protocols or machine-assisted sanding could further improve the homogeneity of the surface.

We compare the hydrophobicity of three different polymer substrates: polytetrafluoroethylene (PTFE, Teflon)—intrinsically hydrophobic; high density polyethylene (HDPE) and polypropylene (PP)—intrinsically slightly hydrophilic. These substrates are sanded with two types of powder additives: hydrophobic calcined petroleum coke derived flash graphene (CPC-FG) and hydrophilic carbon black flash graphene (CB-FG). It is observed that when using CPC-FG to sand the surface, the sanded surface can be superhydrophobic, while when using CB-FG, the surface becomes more hydrophilic than the substrate (Figure 2). This result demonstrates that we can tune the surface wettability over a wide range for various substrates.

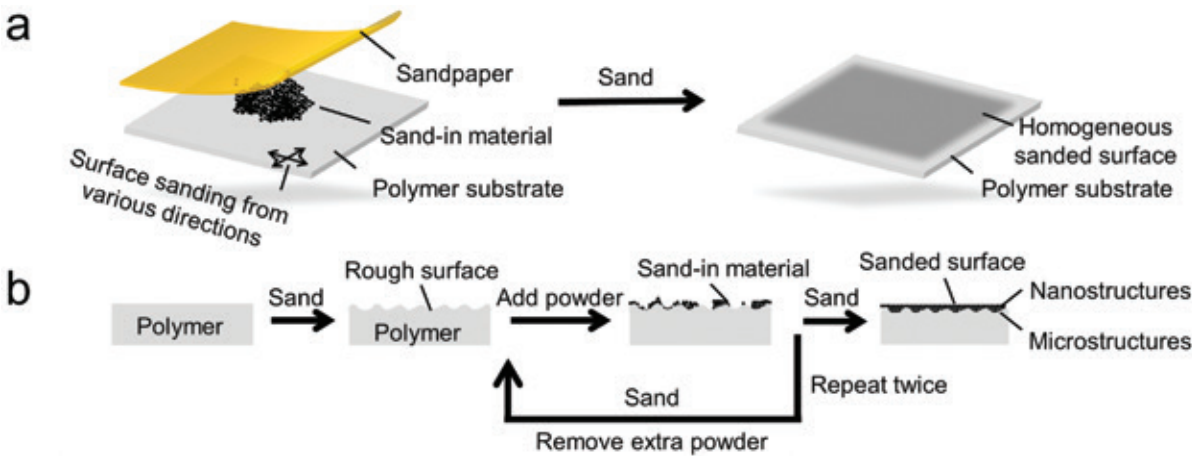
Mechanism of Sand-in Method

The morphologies and structures of the tribofilms are further analyzed to gain a better understanding of the surface modification mechanism of the sanding treatment. A profilometer is used to measure surface roughness at the microscale (Figure 3, see page 16), and atomic force microscopy is utilized to measure surface roughness at the nanoscale. It is noted that:

- Direct sand-in treatment contributes to the micro-roughness
- Powder additives contribute to the nano-roughness

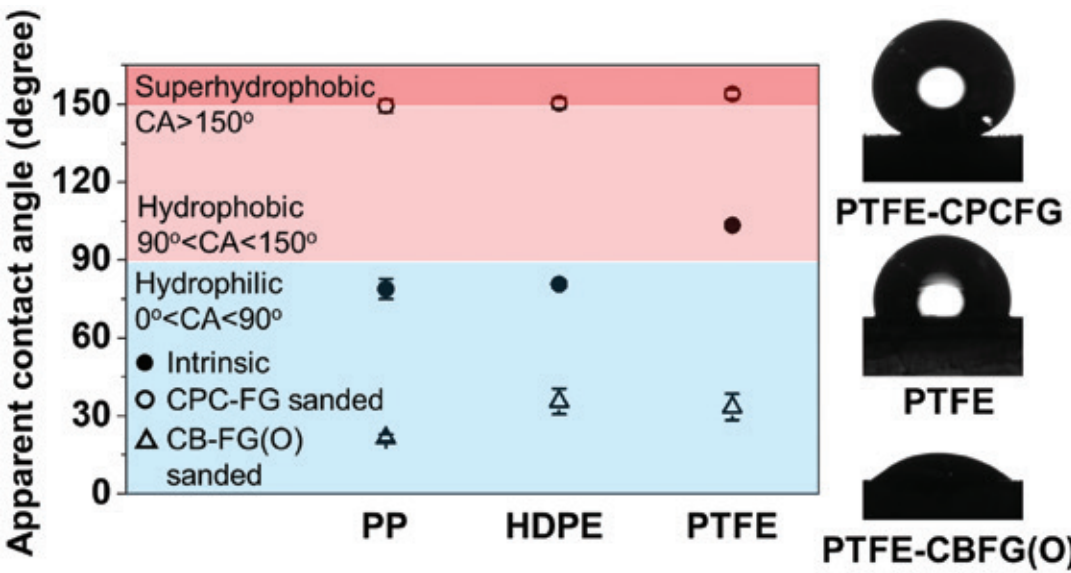
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Figure 1



Polymer interfacial engineering via surface sanding. (a) Schematic of surface sanding for various polymer surface modification. (b) An illustration of surface modification by sanding, repeated three times.

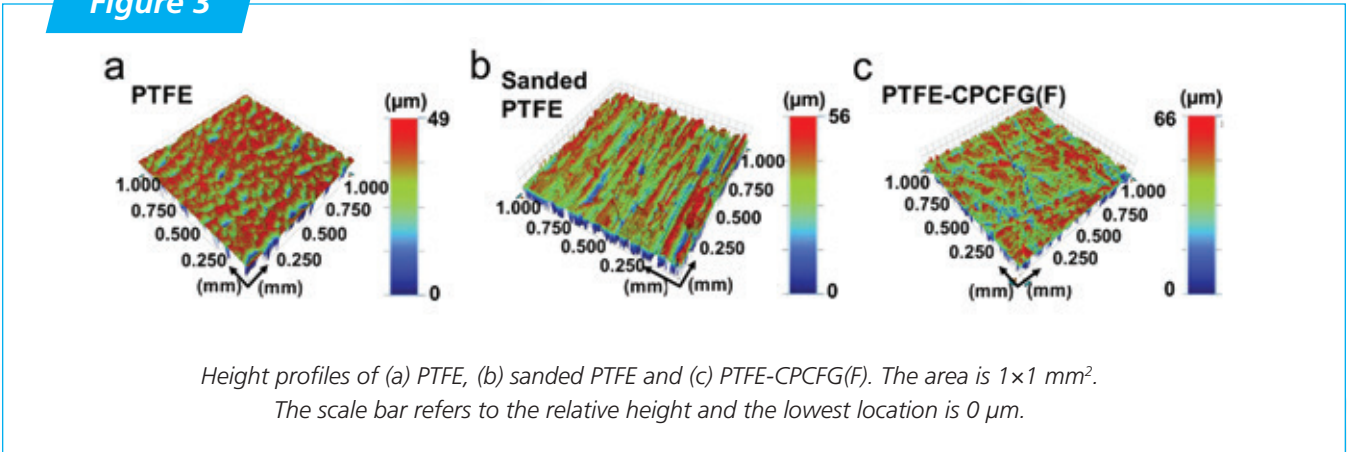
Figure 2



Surface hydrophilicity tests for unsanded and sanded polymer surfaces, including PP, HDPE, and PTFE. The CPC-FG sanded surfaces become superhydrophobic, while CB-FG(O) sanded surfaces are hydrophilic. The grit size of sandpaper is 220. The error bars reflect the standard deviations from at least 3 individual measurements. The optical images at the right side show the static droplets atop PTFE-CPCFG, PTFE and PTFE-CBFG(O).

Robust Superhydrophobic Surfaces

Figure 3



In order to account for the contribution of roughness from the microscale and nanoscale, we modify the Cassie-Baxter model (Figure 4). It is proved that the experimental results follow a modified Cassie-Baxter model³, as shown in eq 1.

$$\cos \cos (\theta^*) = f^{\text{micro}}(\cos \theta_Y^{\text{micro}} + 1) + f^{\text{nano}}(\cos \theta_Y^{\text{nano}} + 1) - 1 \quad (1)$$

Temporal and Mechanical Stability of Sand-In Surfaces

In practical applications, the robustness of the superhydrophobic surfaces is of major importance. The wettability of surfaces can be affected by oxidation and aging after being exposed to air, especially when using organic coatings. Additionally, surfaces can suffer severe degradation due to mechanical abrasion when in contact with other objects. Therefore, the durability and mechanical stability of various sand-in surfaces were assessed (Figure 5).

The contact angle of various surfaces treated by the sand-in method was measured after different periods of time. Experimental results show no obvious change in wettability after 18 months. Samples also showed great thermal stability, as the apparent CA remained constant after being exposed to heat. This result is reasonable, since the vapor pressure of carbon is very low at room temperature and the thermal decomposition temperature is high, at ~600 °C. Additionally, transparent tape is used to test the mechanical stability, and it is observed that the surface can withstand 100 times transparent tape exfoliation. On the other hand, experimental results show that UV-radiation can indeed gradually decrease the CA of the surfaces. This can be explained by graphene's surface oxygen functionalization, which gradually

increases its hydrophilicity. Finally, it is observed that sanded surfaces show good anti-icing performance. The time it takes for water to freeze increases by 2.6% and the adhesion of ice decreases by ~40%, even at ~-40 °C.

Conclusions

In conclusion, a one-step, solvent and water-free sand-in method to prepare robust superhydrophobic surfaces directly atop various substrates has been developed. The surface wettability can be tuned from hydrophilic to superhydrophobic by varying the powder additives and sanding conditions. The sand-in method induces surface modification and the formation of tribofilms. It is revealed that both microstructures and nanoscale asperities contribute to the robust superhydrophobic features of sand-in surfaces. Additionally, it is demonstrated that the sand-in surfaces show good temporal and mechanical stability. These findings could guide the design of surfaces with controlled wettability, and the large-scale application of this technique across a variety of surfaces. ■

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Figures 4 & 5

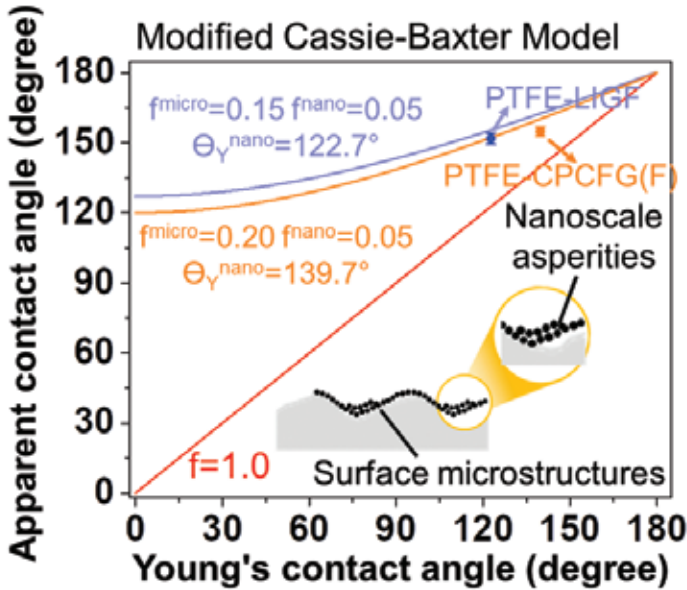
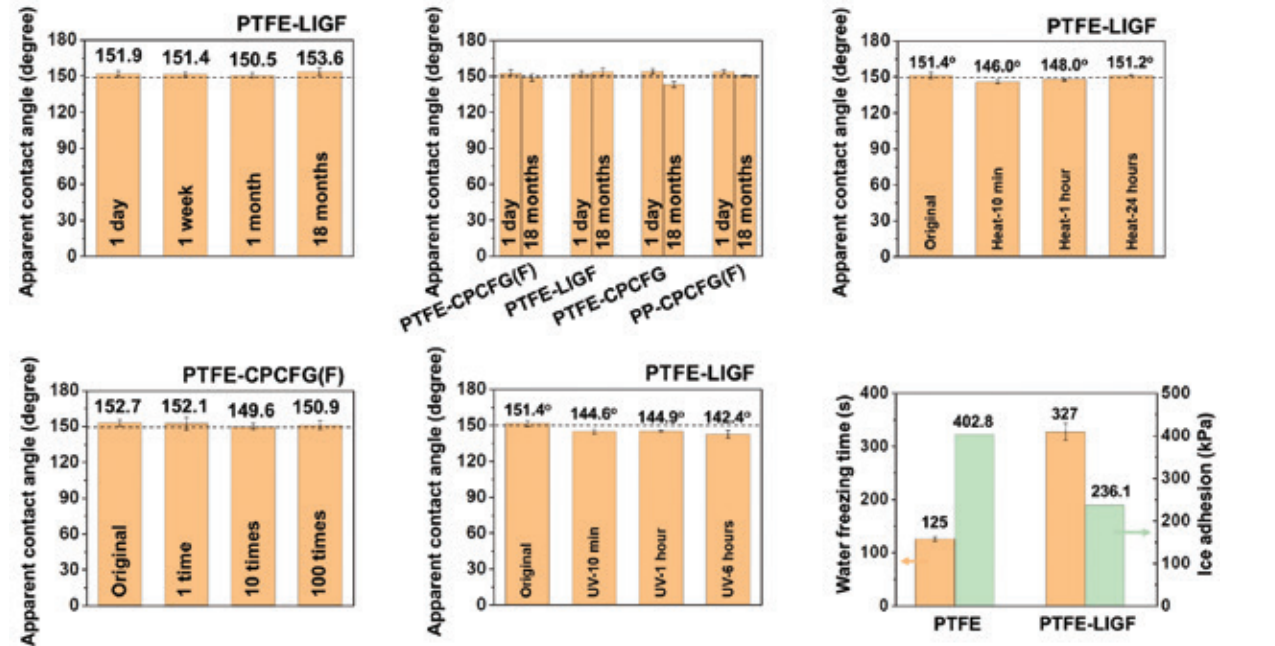


Figure 4, Top. Relationship between the apparent CA θ^* and Young's CA θ_Y for an ideal Cassie-Baxter state at different values of the liquid-solid contact fraction f reflecting the surface structure.

Figure 5, Bottom. Temporal and mechanical stability of sand-in surfaces.



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Q&A

With Pat McSharar

PROJECT CHAMPIONS

MTI is at the forefront of providing global leadership in materials technology to improve safety, reliability, sustainability, and profitability. Technical research projects play a vital part in the success of the MTI mission. While the goal and outcome of each project varies, the overarching commonality is member leadership to develop and nurture each project from inception to completion. These member leaders, dubbed MTI Project Champions, have the unique opportunity to grow leadership skills, network and create tangible solutions alongside other industry professionals.

In this issue, CONNECT spoke with champion Pat McSharar to learn about his leadership experience of project 368 – Best Practices for Working with SMEs.

Q: Please describe your role at DuPont.

A: I am a Materials Engineer for DuPont, joining the company late 2018. My responsibilities are primarily metallurgical failure analysis and materials-related consultation. I am currently the sole proprietor of the corporate failure analysis lab for DuPont, supporting the entire business and all plant sites and offering analysis capabilities / insights unique to the lab.

Q: How long have you been participating as a member of MTI? How have you benefited from your involvement?

A: Officially joined MTI in 2019 after settling into my job. MTI has provided a fruitful network of experts and knowledge of

an industry I am still trying to learn, being relatively early in my career and having come from the aluminum casting industry previously.

Q: How have your fellow MTI members helped you grow in your career and/or in your involvement with MTI?

A: My co-workers were, naturally, the first MTI members to help me by introducing me to MTI and getting me involved early. Having the TAC forum, etc. has also been quite helpful in answering head-scratchers that come up on the job. Being a co-champion of this project with the late Robert Sinko was also invaluable. Robert was a wealth of knowledge and experience, both in the industry and on being a project

champion. Our first conversations were about how to champion an MTI project and he was mentoring me along those lines before we even started fleshing out our requests for funding approval, etc. Kirk Richardson (MTI) has also been immensely helpful and encouraging through the whole process, especially after the loss of Robert.

Q: How did you become a champion of this project? Please tell us how you came to take on this role and what skills and/or experience you hold that helps the project and team to succeed.

A: Maurice Wadley, our corporate rep, approached me after the 2020 Symposium in Baton Rouge and asked if I would be interested

in co-championing a project. MTI was looking for someone relatively early in their career and mentioned how this would be a very good opportunity to get involved in MTI and put my name out there. I think with this being my first project, I am in the position to sit back and absorb the comments and insights from other project team members to learn what the community would want and expect from this project and make sure we go in that direction.

Q: How was the project idea inception? Is the current state of the project the same as the original idea? If not, how has it changed?

A: This project came out of the 2020 symposium and the desire for a focus on knowledge management. This project and the Business Cases for Knowledge Management were the two that moved forward after 25 potential projects were brought up and narrowed down in the KM PDC. Our project is very near completion and our plan is to present at the TAC meeting in Milwaukee, in June of this year. While the project has evolved and adapted over its course, it is still true to our original desire to have a body of work that assists member companies in their efforts for knowledge capture from their SMEs and the recording/transfer of that knowledge to others who will need it.

Q: Tell us about Project 368 Best Practices for Working with SMEs.

A: Best Practices for Working with SMEs is a toolbox for individuals to reference when capturing knowledge from those in their

company. We highlight the reasoning behind why doing so is prudent for those whose management may not be as enthusiastic about taking time for such endeavors, as well as MTI as a repository for knowledge crucial for the chemical process and refining industries. Our book has examples of questions to ask and lines of inquiry for flow when taking the time to sit and talk with SMEs, how to find the right expert, etc. While directed at materials engineers, the insights contained in the book can be applied more broadly to other disciplines within member companies. Also presented are examples of documentation and software/database options to assist with the capture of information, which makes it easier to retain and transfer that information to those who will need it in the future. As we reach the completion of the project, edits are being made to make the book as user-friendly as possible and suitable for all who wish to use it, whether they read it cover to cover or head straight for the toolbox section.

Q: Please explain what you have learned from your previous experiences on a project team and how it has helped you champion this project.

A: I have no previous experience being on a project team, let alone champion. This was an opportunity to jump head-first into MTI involvement and having Robert and Kirk was invaluable in my climbing up the learning curve. Being so green has also shown me that I don't know what I don't know and the success of this project, and myself as a champion relies on

learning what the MTI community wants and how we can best provide that. I have also learned so much about MTI as a whole as I am still new to membership in general.

Q: What are you gaining from this experience as a project champion?

A: In addition to what I've mentioned already, what I have gained from championing / co-championing this project is the confidence to be involved in MTI and to continue to be involved when and where I can be additive to the community and/or project.

Q: What are you passionate about outside of work and MTI?

A: I am pretty active outside of work and have been for many years. Between being a competitive rower (though not nearly as competitive as I was back in college), training jiu jitsu, and (volunteer) firefighting, I am quite busy. For better or worse, I like to throw myself into challenging mental & physical pursuits. Jiu jitsu, for example, can be described as a physical chess match. One must learn not only techniques associated with the martial art, but how to manage and react under pressure (both mental and physical). Besides the occasional aches and pains, the only downside from jiu jitsu has been a little bit of cauliflower ear.

CONNECT thanks Pat. Members interested in the 368 project can learn more at www.mti-global.org. ■

HOW SHIFTING PERSPECTIVE CAN IMPROVE CUI PROGRAM EFFICIENCY

> CONTINUED FROM PAGE 5

monitoring locations (CMLs) that they have been observing for years but have yet to figure out if what they see is poor repeatability or if it is actually corrosion.

IDMS Data Review & Validation

A powerful statistical method that can be used for IDMS data review and clean-up is Bayesian analysis. Thickness measurements can be affected by a range of factors and a Bayesian analysis incorporates prior knowledge thereby allowing factors, such as calibration or measurement errors and other variabilities to be accounted for and assessed. In the context of thickness data, prior knowledge can include information about the equipment being measured, such as the expected range of thickness values or the historical trends in thickness over time. Combining thickness measurement data with prior knowledge will improve the overall accuracy and reliability of the IDMS data. In addition, after defining the statistical model, a Bayesian analysis can estimate the acceptable limits of the thickness readings inside the IDMS, or when new readings are input. It is recommended to conduct this initial clean up if there are three or more readings in the CMLs' history. Using the updated data will make more accurate and reliable predictions and assessments of the recorded thickness measurements.

Once the IDMS has been verified and cleaned, the data is now ready to calculate existing evaluations. Accurate and reliable thickness data allows companies to use the Bayesian analysis to identify the physical areas of the plant that are at a higher risk of corrosion and then prioritize inspections and maintenance activities accordingly. Applying the statistical method will remove the broad spectrum and random inspection methods currently in place at many facilities.

CUI is a particularly challenging damage mechanism because it is difficult to detect and can cause significant damage to equipment. Utilizing new technologies, such as a Bayesian analysis, companies can streamline CML-level decision making and shift their focus towards identifying and mitigating CUI. Analyzing piping thickness data will help maintenance personnel identify the high corrosion areas and build an inspection and maintenance strategy that is only focused on the high-risk equipment. Bayesian analysis will help plant personnel improve the accuracy and reliability of the corrosion management program and reduce the time spent chasing false positives or non-existent corrosion in internal corrosion programs.

The use of advanced data analysis tools can help companies optimize their overall corrosion management programs, resulting in further cost

savings and improved asset reliability. The savings can be used to create a comprehensive strategy to manage the effects of CUI and invest in new technologies or techniques to detect and mitigate CUI, such as insulation systems or rust-resistant coatings. Developing corrosion models and predictions based on data analysis, companies can proactively anticipate corrosion-related problems to achieve reduced downtime, lower maintenance costs, and improved equipment performance.

Applying advanced analysis of piping thickness data and new technology to internal corrosion management programs can result in significant efficiency gains for a company's mechanical integrity and reliability programs. This practice of proactively addressing potential internal corrosion-related issues allows companies to develop effective strategies to prevent costly equipment failures and downtime. Once an internal corrosion program is in an optimized state, companies can shift their focus towards detecting and mitigating CUI. Therefore, the use of data analysis in thickness management programs provides savings that can be used to create a comprehensive approach to managing the effects of CUI, resulting in further optimization of corrosion management programs and a safer and more reliable plant. ■

REMEMBERING SOPHIE WASTIAUX

FORMER EUROTAC CHAIR AND PROJECT CHAMPION

In December 2022, MTI learned of the death of Dr. Sophie Wastiaux and conveys condolences to all who mourn the loss of our friend and contributor. Wastiaux was a Senior International Expert at Air Liquide and was the main driver for Air Liquide's MTI membership in 2004. A strong supporter of the MTI EuroTAC group and meetings, she played an active role as project member of many MTI projects born from EuroTAC, such as Metal Dusting, H2 PSA Fatigue, and HTHA. She was also the Champion of the first and second HTHA projects and led them successfully to completion.

In 2017, Wastiaux became the EuroTAC Vice Chair but quickly



Sophie Wastiaux

transitioned to become the leader of EuroTAC when there was an unexpected vacancy in the Chair role. For

three years, she led the group with dynamism, liveliness, authority, and willingness to reach consensus in order to successfully develop projects funded by MTI. Her leadership during the EuroTAC meetings in Tarragone, Frankfurt, Cambridge, Versailles, Basel, and Amsterdam was key to their success. In her role as EuroTAC Chair, she also served as Ex-officio on the MTI Board of Directors.

She was thought of by many as a professional, expert, guide, advisor and leader, who exuded grace and kindness in all she did. Sophie will be greatly missed at EuroTAC and by the entire MTI community. ■

ASIATAC REPORT

> CONTINUED FROM PAGE 8

Day two will feature a two-part special training session on stainless steels and nickel alloys. The first will focus on "Weld Repair of Stainless Steels and Nickel Alloys," led by Gary Coates. "There are many welding challenges with repair of stainless steel and nickel alloy equipment that has been in service in a refinery, petrochemical or chemical plant," explains Coates. "This training session will help operators to ensure the repair is done in a way that gives the best results." Coates will cover several important topics, such as selection of filler metals and welding processes as well as the difference between welding for high temperature services and corrosive services.

The second training session will involve two lectures on the "Properties and Applications of Duplex Stainless Steels," taught by Jan Li

and Dragon Hao. "The duplex family of stainless alloys are known as 'problem-solvers,'" explains Coates. "However, it is important to understand where they should and should not be used, and their differences compared to standard stainless steels." Li and Hao will cover these details and more in this informative course.

Coates and MTI Associate Director Paul Liu, who supports AsiaTAC, have both been very involved in planning the upcoming meeting and are also in the process of finishing MTI Project 367. This project is actually phase II of project 269, Corrosion Data of the Most Commonly Used Corrosion Resistant Nickel Alloys. Project 269 was the first joint effort to collect, analyze, and publish corrosion data of nickel alloys from various major global suppliers.

According to Liu, the primary goal of MTI project 367 is to collect and build up a corrosion rate database for ten grades of commercially available nickel alloys. "When the project is completed, the safety and efficiency of nickel alloy applications in the CPI can be improved," he points out. "MTI producer companies will be able to use the recommended testing methods and corrosion reference data to compare and evaluate the various nickel alloy suppliers. MTI supplier companies will be able to use the corrosion reference data to communicate with the customers in a more effective and convincing way." A final report is expected at the Spring Meeting.

For more information on AsiaTAC or to register for an upcoming AsiaTAC meeting, visit mti-global.org/events/asiatac-meeting. ■



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To-date, MTI has delivered more than eight FRP Training Courses

around the world, one of which included the Dual Laminate course content, and one stand-alone Dual Laminate training in the U.S.

Interested in learning more or registering? Scan the QR code or visit www.mti-global.org/about/events/dual-laminate-frp-training for details, registration and a brief video sample of the content from the Dual Laminate Training held in November 2021. ■

