



# COMMUNICATIONS

MATERIALS TECHNOLOGY INSTITUTE OF THE CHEMICAL PROCESS INDUSTRIES, INC.

1215 Fern Ridge Parkway • Suite 116 • St. Louis, MO 63141-4405 • Telephone: 314/576-7712 • Fax: 314/576-6078 • E-mail: mtiadmin@mti-link.org

## High Temperature Materials — The New Frontier

The High Temperature Resource Advisory Group under the leadership of Ken Baumert has tackled a wide range of problems since its inception in February 1998. The subjects range from the prediction of material behavior under elevated temperature environments to the practical problems associated with the fabrication and welding of newer alloys to be used in extreme conditions.

The three largest efforts are, "Enhancement & Commercialization of the Alloy Selection System for Elevated Temperatures - ASSET," "Advanced Intermetallics & Alloy for Ethylene Crackers," and a "Metal Dusting Study."

In addition to these, MTI is cooperating with the American Society for Testing and Materials (ASTM) in promulgating a standardized test for the discontinuous gas carburization of alloys. Professor Hans J. Grabke included this procedure in his publication "Carburization - a High Temperature Corrosion Phenomenon," published by MTI in 1998.

As a follow-up to the subject of carburization, which occurs at temperatures  $>800^{\circ}\text{C}$  ( $1400^{\circ}\text{F}$ ), the RAG initiated a literature review of the related problem of metal dusting, which occurs generally between  $350^{\circ}\text{C}$  and  $900^{\circ}\text{C}$  ( $660^{\circ}\text{F}$  and  $1650^{\circ}\text{F}$ ). This review by Dick Jones is now available to the RAG and is undergoing technical review before being considered

for publication. It is available to members on the web site. Summaries of the activities going on in each project are given below.

### ASSET

This project provides the solutions to material selection for high temperature environments containing oxygen, carbon monoxide, carbon dioxide, water vapor, hydrogen sulfide and other sulfur compounds. It is a computer-based program which has a very large database of environments and commercial materials. Given a set of conditions, the program searches the database for materials that have the lowest corrosion rates utilizing thermodynamic calculations to determine corrosion products.

This project initiated with a well-developed database and program, assembled from a single source of information. The enhancements sought by this project include the expansion of the data base with data from other participants and the addition of newly produced data by Oak Ridge National Laboratory's experiments under the aegis of the DOE. The program has been under way for nearly a year and the first enhancement, ASSET 5.1, was released to the RAG in August at a meeting at ORNL. Additional details may be found on the MTI Web site under the project heading.

### ADVANCED INTERMETALLICS

The CPI is undergoing a large expansion in capacity for producing ethy-

lene, one of the major building blocks of the entire plastics industry. Energy usage in the reaction furnaces is a major cost factor. Improvements in furnace operation, utilizing new materials for furnace tubing, will provide great benefits to the industry. Oak Ridge National Laboratory has been developing intermetallic compounds to serve as the basis for furnace tubes. This project brings together member companies who can fabricate the tubes from the new materials with the chemical company members who operate the furnaces. Together they are developing the manufacturing, fabricating and joining techniques required for a new tube material, along with the necessary qualifications to make sure the material has lasting strength without becoming carburized or coked up. Two major seminars have been held

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Materials Technology Institute of the Chemical Process Industries, Inc. (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.



## Products Fall 2000

### UNUSUAL CORROSION PROBLEMS IN THE CHEMICAL INDUSTRY P. Dillon

Finally, finally, finally. Hot off the presses is MTI's latest publication *Unusual Corrosion Problems in the Chemical Industry* by C.P. Dillon. This publication was developed from a series of informal discussions held at various NACE meetings. The information is supplemented with data from reviews of other literature and minutes from the MTI technical advisory forum and information exchange. The book discusses case histories in known environments such as caustic, various

acids, hydrocarbons, halogens and organic chemicals with unpredictable problems which in some cases led to catastrophic failures. Hardcover, 262 pages. ISBN: 1-57698-021-9. \$47.50, members, \$95, non-members. Call 304-522-0086 or order on-line at [www.mti-link.org](http://www.mti-link.org).

### PERMEATION THROUGH POLYMERS FOR PROCESS INDUSTRY APPLICATIONS R.P. Campion

On the presses at the time of this writing, and available now, is the long awaited *Permeation through Polymers*, by R.P. Campion. This publication provides both theoretic-

cal and practical information on the permeability of various polymers used in the chemical process industry. Testing methodology was developed and a series of guidelines produced. Hardcover, 128 pages. ISBN:0-444-50052-9. \$62.50, members, \$125, non-members. Call 304-522-0086 or order on-line at [www.mti-link.org](http://www.mti-link.org).

### WHAT'S TO COME...

Keep posted on the Web site [www.mti-link.org](http://www.mti-link.org) and look for upcoming volumes in the Materials Selector Series. MS-4, *Materials Selection in Hydrogen Fluoride and Hydrofluoric Acid*.

## High Temperature Materials (continued from page 1)

to present the ongoing results of the first six months' work of this three-year project. Details may be found on MTI's Web site.

### METAL DUSTING

Metal dusting (MD) is an aggressive attack which destroys the integrity of metals used in high temperature environments where carbon attacks iron, nickel or cobalt-based alloys and produces a powdery mixture of the elements. The intent of this project is to first delineate the areas in which MD can occur with a large variety of commercial alloys, and then to select the most resistant materials and coatings.

A statistically designed experiment has been formulated which will be used to survey a large palette of iron and nickel-based wrought alloys. Argonne National Laboratory was selected to carry out the experimental program, with the oversight and cooperation of MTI members. The members are supplying alloy sam-

ples and specifying the environmental conditions. Field tests of some materials are being carried out in known MD susceptible equipment; additional trials will be performed, once optimum materials are suggested by laboratory data.

### WELDING HIGH TEMPERATURE ALLOYS

Materials used at elevated temperatures undergo metallurgical change in structure which is termed aging. These microscopic alterations can change the response of the alloy to severe swings in temperature that occur during the welding process. Cracking, loss of ductility or strength, or changes in other properties may take place, sometimes in a delayed fashion after the welded piece has been put back into service. The RAG has established a Resource Group to discuss this problem and exchange information, possibly leading to weld procedures that avoid these problems.

### OTHER TOPICS

Members are free to bring problem areas to the attention of the RAG at any time. Frequently, a question is asked during the Technical Forum that raises the interest of several members. In this manner, a Resource Group was established on the topic of alloys used in expansion bellows. Expansion bellows are used to connect pieces of equipment that see large variations in temperature during operation, especially in the high temperature regime. Currently a survey of specific problems with bellows materials is being made to see if a test program can be established. The objective is to provide a better alloy for the purpose of fabricating expansion bellows for use at high temperatures.



## Project News

### MICROWAVE NDE

The Microwave NDE Resource Group has accepted the final report for the MTI-initiated and sponsored project to determine the limitations of microwave NDE for testing polymer structures. The contractor is KDC Technology Corporation, Livermore CA.

A key result of the project is the discovery of new sensor design principles that allow an order-of-magnitude increase in penetration depth. In typical FRP structures, the increase is from ~ 0.1 inch to more than one inch. Paradoxically, despite being so much more sensitive, the new sensors are not nearly as susceptible to false alarms. This new design may be patented.

This laboratory project was designed to determine the feasibility of NDE in situ detection and characterization of subsurface water and/or acid permeation or blistering on the inside surface of thick-walled fiber reinforced polymer (FRP) pipes or vessels. The microwave sensors are contact applicators intended for hand-held movement on the outside surface of the vessel as an alternative to entering the vessel and performing visual inspection. In the case of a thin-walled material, the nature of the anomaly, water vs. acid, can be distinguished owing to their different dielectric properties.

The sensor's sensitivity to subsurface anomalies depends on penetration depth of the sensor's electromagnetic field and on the degree of dielectric contrast between the anomaly and the FRP background. In turn, these depend on a number of combined factors, such as the area and thickness of the anomaly, its dielectric constant, loss factor and so on. The report gives quantitative examples of how different factors and different types and dispositions of anomalies affect the sensor operation, and attempts to quantify some of the probable outer limits of sensor performance. Detection of aqueous and ionic fluid (water, acid, base) permeation is the unique niche of this type of sensor because of the high contrast in loss factor ( $\epsilon''$ ) compared to FRP.

The ultimate goal is a sensitive hand-held probe about the size and weight of a wireless phone. Toward this end, one of the new applicators was physically and electronically integrated to a miniaturized controller that had been developed in-house for another customer. A few of the tests were repeated with nearly identical results and there was no loss of information, thereby demonstrating the feasibility of ultimately achieving a hand-held nondestructive inspection (NDI) probe.

The major near-term application for this technology is HCl storage tanks where permeation and blistering are the major

forms of degradation. Therefore, to demonstrate the utility of the technology, a follow-up project has been initiated to provide field-testing of in-use FRP HCl tanks. This would document the portability of the equipment and demonstrate its effectiveness in a field environment.

To accomplish this field-testing, a new potential project titled "Field Trial of Microwave NDE" was formed. This is a joint project with fv (NDE) and ff (Polymer) Resource Advisory Groups.

The plan is to seek funding for the field-testing project during the February 2001 TAC and BOD meetings.

Part of the report was accepted for publication in *Subsurface Sensing Technologies and Applications*, with acknowledgment to MTI. This will appear in the October, 2000 Special Issue of *Subsurface Aquametry* and is titled "Novel Microwave Sensors For Detection of Subsurface Moisture and Acid."

For MTI members, this report may be viewed on the MTI Web site ([www.mti-link.org](http://www.mti-link.org)) in the File Download area by clicking on Project 126-98.

## MTI Announces Establishment of the MTI Fellow Award

The MTI Board of Directors has decided to recognize individuals that have been instrumental in the development and progression of MTI. On that basis the BOD has created the Fellow Award. Eligible candidates can be active or retired employees of member companies, active or retired staff members, or outside employees/contractors. The nominee must have at least 10 years total involvement with MTI. Any employee of a member company can nominate an individual with endorsement from two other company's designated representative or technical advisory council representative. Nominations will be solicited in October with the intent of announcing the awards in February of the following year. Fellows will be awarded a plaque, specialized name tags and letters of commendation combined with public notices.

Further details and nomination forms can be found on the Web site, [www.mti-link.org](http://www.mti-link.org). Look for our first Fellows in the Spring issue!



# Project Champions

MTI recognizes the contributions of their members who volunteer their time, effort and energy as project champions to guide and direct projects to their fulfillment.



**ROBERT SINKO**  
SENIOR MATERIALS ENGINEER  
EASTMAN CHEMICAL

My interaction with MTI started in June 1993, almost one year after I started working for Eastman Chemical. I am thankful Gary Whittaker, our designated representative and board member,

encouraged my involvement by including me at the meetings.

Working with the MTI staff has been a pleasure. MTI staff have proven to be very dependable, helpful and reliable with all kinds of information. Their organizational skills in putting together meetings and teleconferences are awesome.

Working with MTI members is truly a professional experience. They are an excellent source of knowledge, wisdom and real world experience. You quickly learn that there is more than one way to solve a problem, as well as different perspectives on how to approach a problem.

As for my interaction with the elastomers Resource Group, it certainly seemed that I was asking the bulk of the questions about elastomers at the Technical Forum. I believe many other MTI members also shared the common metals background and were uneasy with the vendor/distributor claims. When enough of the members showed an interest in creating Resource Group, I was interested in becoming champion.

I became a project champion for several reasons. Elastomers was a topic of very great interest for me and I saw an opportunity to expand my materials skills and knowledge. I knew it could be of benefit to both my professional growth and to my value to Eastman. We have four very good metallurgists, but no real lead in elastomeric materials. I was also interested in becoming more than just a participating Resource Group member and wanted to try a leadership role. I was challenged! I would also like to acknowledge the input of Jim Alexander, DuPont/Dow Elastomers.

Obviously, one valuable aspect of being Champion is that it is possible to bring the knowledge back to our company and see the monetary difference it has made in our pur-

chasing habits. We have worked closely with our on-site pump and valve shop to standardize on elastomeric o-rings and seals with the knowledge gained from this Resource Group.

Personally, I have found it to be a valuable and rewarding lesson guiding a group with such diverse backgrounds and goals.

Professionally, the role of champion has allowed me to see how good a product we could produce. My copy of the Elastomer Guide book is well used.



**BRIAN J. FITZGERALD**  
SENIOR ENGINEERING  
ASSOCIATE  
EXXONMOBIL CHEMICAL  
COMPANY

Brian Fitzgerald has been the ExxonMobil Company representative since January 1994.

ExxonMobil is one of the charter members of MTI.

Brian is currently project champion for MTI/DOE project on "Advanced Intermetallics & Alloy for Ethylene Crackers" which is developing intermetallic materials for use in the production of ethylene. He is also champion of the proposed project "Design and Operation of Water Cooled Heat Exchangers," the intent of which is to produce a guideline document for reducing maintenance costs and improving the performance of heat exchangers utilizing cooling water as a heat transfer medium.

The highly leveraged approach of MTI has been an ideal format for Brian to work his company's high priority issues and get large returns on his time. The forums provide access to other member company representatives and information on emerging technology. This participation in coordinating and developing industry-wide programs presents the opportunity to think, plan and act on a global basis, which is an important skill for today.

The availability and dedication of staff to organize and document meetings, and prepare RFQ's, is key to quick project development and return on time invested. The broad network of knowledgeable materials professionals is an enjoyable and informative experience.



## Welcome New Members...

### IESCO, INC.

IESCO, Inc. (International Energy Services Company) with corporate headquarters located in San Pedro, California, provides full service inspection and engineering services to: petroleum refineries, petrochemical industries in such areas as ammonia, methanol and urea production, power generation industries (fossil fired and nuclear generating plants) and oil and gas production facilities (onshore and offshore), both nationally and internationally. Brian Shannon, President & CEO, established the company in 1986, with its roots in welding engineering and nondestructive examination services (NDE).

IESCO offers NDE, engineering and technical services which include a non-intrusive evaluation of critical plant equipment utilizing ultrasonic examination and electromagnetic examination.

This year, IESCO acquired Mobile Inspection Services and Framatome's Reformer Tube Inspection business. Mobile Inspection has a thirty-five year history of providing inspection

services to the fossil and nuclear power industries and enhances IESCO's presence in the nuclear and conventional power generation markets. Framatome's reformer inspection business has been incorporated into IESCO's 'H' Scan® technology group which now supports a highly experienced team that have conducted examinations of reformer tubes worldwide. Brian Shannon is IESCO's TAC Representative.

### HITCO CARBON COMPOSITES, INC.

HITCO Carbon Composites, Inc., located in Gardena, CA, manufactures advanced composite materials for a variety of applications. The company specializes in the engineering, development, and manufacturing of novel materials technologies. End uses for HITCO's products include aircraft and automotive brake components, rocket motor nozzles, aircraft components, submarine bow domes, heat shields, and components used in semiconductor manufacturing. HITCO, a subsidiary of SGL Carbon (Wiesbaden, Germany), has 300 employees and sales of \$70 million per year. For the chemical process

industry, HITCO makes CHEM-CARB™ Carbon/Carbon Composites, which consist of a carbon fiber surrounded by a carbon matrix. These strong, lightweight composites have excellent chemical resistance. They can be used as column and reactor internals for service in strong mineral acids, in organic acids, in caustic, and in most other organic and inorganic chemical environments. Applications for CHEM-CARB products include trays, tray supports, column liners, column packing, sparger and distribution tubes, thermowell sheaths, spray nozzles, and I-beams and other support members.

Winn Darden is HITCO's TAC Representative. Gerry Taccini is the Program Manager for CHEMCARB products.

## Collaboration with NiDI Continues

The Nickel Development Institute (NiDI) provides application guidance for nickel bearing alloys. Since most corrosion resistant alloys contain substantial nickel, NiDI has an active interest in developing and communicating information relating to the proper, cost-effective use of these alloys in the CPI. MTI shares this interest; this shared interest has led to active, continued, and mutually beneficial interaction.

Interaction usually takes the form of NiDI

providing financial support for selected MTI projects in addition to continuing interaction between MTI and NiDI's technical consultants.

Most recently, NiDI provided support totaling \$25,000 to MTI projects concerning metal dusting, and advanced intermetallics for use at high temperatures and another \$3,500 to support the joint ASTM/MTI standards program.

Both organizations also support the work of C. P. Dillon to update the material selection

guidance system (Cor•Sur) marketed by NACE. NiDI contributed \$5,000 towards this effort. In addition, NiDI and MTI have jointly organized a European information exchange meeting to be held in Brussels, Belgium in November 2000.



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of the Chemical Process Industries, Inc.  
1215 Fern Ridge Parkway, Suite 116  
St. Louis, MO 63141-4405  
www.mti-link.org

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## Contact:

Submit all correspondence regarding  
MTI Communications to:

Materials Technology Institute of the  
Chemical Process Industries, Inc.

Attn: MTI Communications  
1215 Fern Ridge Parkway  
Suite 116  
St. Louis, MO 63141-4405

1-314-576-7712 (telephone)  
1-314-576-6078 (fax)  
mtiadmin@mti-link.org

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# Calendar of Events

<u>MEETING</u>	<u>DATES</u>	<u>LOCATION</u>
MTI R.G. Meetings MTI TAC MTI ANN MTI BOD	OCT 23 OCT 24 & 25 OCT 25 OCT 25	Embassy Suites Hotel Charlotte, NC
MTI European Meeting	NOV 15 & 16	Brussels, Belgium
MTI R.G. Meetings MTI TAC MTI BOD	FEB 26 FEB 27 & 28 FEB 28	Sheraton Sand Key Hotel Clearwater Beach, FL
MTI R.G. Meetings MTI TAC MTI BOD	JUN 4, 2001 JUN 5 & 6 JUN 6	Memphis Marriott Memphis, TN