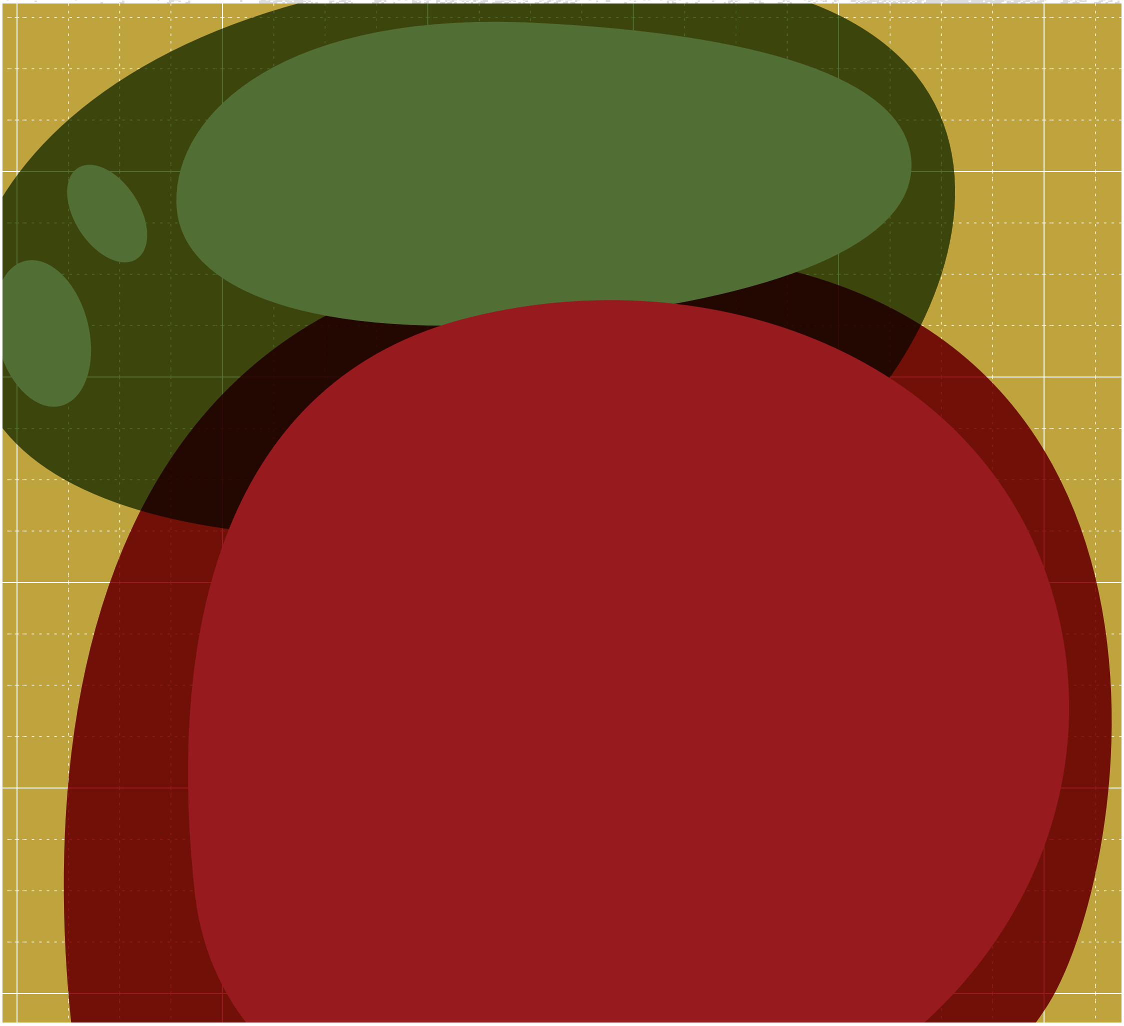
CORROSION

Material Selection, Reliability and Corrosion — Challenges and Opportunities

1 March 2018



TEXAS A&M UNIVERSITY at QATAR

NATIONAL CORROSION & MATERIALS RELIABILITY LAB

Inaugural Research Planning Workshop

"Material Selection, Reliability and Corrosion – Challenges and Opportunities"

Hosted by:
Mechanical Engineering Program, Texas A&M University at Qatar
& TEES National Corrosion and Materials Reliability Laboratory

Venue:
Student Center, Hamad Bin Khalifa University, Education City

Thursday, 1 March 2018

Welcome

The state of Qatar is peninsula surrounded by the Arabian Gulf with a 359-mile coastline and a total area of 4,500 square miles. One of Qatar's strategic goals as stated in the Qatar National Vision 2030 is to transform the country into a knowledge-based society and diversify its economy by heavily investing in education and research. Since its inception in 2003, Education City – with its-world renowned branch campuses, such as Texas A&M University at Qatar, and its various research funding agencies – has transformed the education system and research culture in the country noticeably. Texas A&M at Qatar's vision is to be the premier provider of engineering education in the region, a significant contributor to knowledge internationally and an essential resource to the State of Qatar. The Mechanical Engineering Program at Texas A&M at Qatar is an extension of the Department of Mechanical Engineering at Texas A&M University in College Station, Texas (USA), one of the best and largest mechanical engineering departments in the U.S. and around the world. The Mechanical Engineering Program offers essentially the same study program as that offered on the main campus in the U.S., and conducts research and services in related technical areas.

The National Corrosion and Materials Reliability Laboratory (NCMRL) is a leader in research and technology efforts for materials degradation and reliability. NCMRL's main focus is research and development within corrosion science and engineering. Through research, education and training, and the testing of materials, NCMRL provides material selection, mitigation strategies and lifetime prediction tools to industry. NCMRL fosters innovation, collaborative research, education and training in corrosion science. NCMRL serves as a world-class corrosion education and research laboratory creating tomorrow's leaders in corrosion science and engineering.

Workshop Rationale and Objectives

The goal of today's workshop is to highlight materials selection, reliability and corrosion challenges in Qatar to forge new, interdisciplinary, collaborative research initiatives for 2018 and beyond. This event will establish a platform for communication and knowledge-sharing among experts from academic institutions, research centers, industry and government organizations in Qatar. In particular, maintaining critical infrastructures and key oil and gas assets is of strategic importance for the State of Qatar. In order to foster discussion, a group of scientists active in related fields from local industry and subject-matter experts from top universities in the United States have been invited to share their latest discoveries. We hope today's workshop will illustrate the importance of industry, academia and government partnerships in developing scientific solutions that directly impact the world around us.

We hope you enjoy the workshop.

Steering Committee

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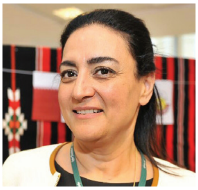
Speakers

A team of experts in corrosion engineering, materials reliability, design, testing and modeling and coatings, and industry and government guests will participate this workshop.



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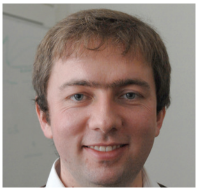

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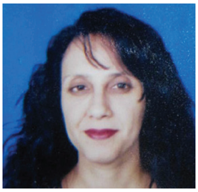

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Agenda
Thursday, 1 March 2018

7:30-8 a.m.	Registration
8 a.m.	Welcome Remarks **Dr. César O. Malavé** Dean, Texas A&M University at Qatar
8:10 a.m.	Remarks by **Dr. Eyad Masad** Texas A&M Engineering Experiment Station
8:20 a.m.	Remarks by **Dr. Fouzia Hannour** Qatar National Research Fund, Qatar Foundation
8:40 a.m.	Corrosion Challenges in Gas Production and Processing: An Overview of Corrosion Research at Qatar Shell Research & Technology Centre **Dr. Nick Laycock** Qatar-Shell Pearl GTL
9:10 a.m.	Overview of NCMRL and Texas A&M at Qatar Research Activities: Reliability Modeling of Different Assets Based on Extreme (Corrosive) Environment: Trends and Opportunities **Dr. Homero Castaneda-Lopez** Texas A&M University, USA Design and Testing of Coatings/Materials for Extreme Environments **Dr. Bilal Mansoor and Dr. Chaudhry Ali Usman** Texas A&M University at Qatar
10 a.m.	Coffee Break

10:20 a.m.	Relating the Crystallographic Character of Individual Grain Boundaries to Their Hydrogen Embrittlement Susceptibility **Dr. Michael Demkowicz** Texas A&M University, USA
10:40 a.m.	Materials for Extreme Conditions for Reduced Friction and Wear **Dr. Andreas Polycarpou** Texas A&M University, USA
11 a.m.	Graphene Composite-based Anticorrosion Coatings **Dr. Ahmed Abdala** Texas A&M University at Qatar
11:20 a.m.	Progress in the Stochastics Modeling of Pitting and Cracking in Stainless Steels Exposed to Oil and Gas Producing Environments **Dr. Raymundo Case** Texas A&M University, USA
11:40 a.m.	Smart Autonomous Systems for Pipeline Defect Detection **Dr. Mansour Karkoub** Mechanical Engineering Department Texas A&M University at Qatar
Noon	Lunch
1:10 p.m.	The Role of Emerging Grain Boundary at Iron Surface on Metal Dusting Initiation **Dr. Fadwa Elmellouhi** Qatar Environment & Energy Research Institute Hamad Bin Khalifa University, Qatar
1:30 p.m.	In-situ Thermomechanical Corrosion Fatigue Testing **Prof. Dr.-Eng. Nikolaos Michailidis** The Aristotle University of Thessaloniki, Greece

1:50 p.m.	Failures in Qatar's Oil and Gas Installations Due to Atmospheric Corrosion **Dr. Hanan Farhat** College of North Atlantic-Qatar
2:10 p.m.	Corrosion Work in the Centre for Advanced Materials, Qatar University **Dr. Aboubakr M. Abdullah Ali** Qatar University
2:30 p.m.	Rehabilitation of Corroded Sheet Piles Quay Wall at Old Doha Port (Realistic Case Study) **Dr. Samir El-Sayed Shaykhon** Public Works Authority, "Ashghal"
2:50 p.m.	Panel Discussion Moderators: **Dr. Bilal Mansoor and Dr. Homero Castaneda-Lopez**
3:30 p.m.	Closing Remarks

Invited talks

Qatar National Corrosion RD&T Roadmap – The Bigger Picture

Dr. Fouzia Hannour
Director/Lead Strategy , Energy and Environment Pillar
Qatar National Research Fund
Qatar Foundation

Bio: Dr. Fouzia Hannour leads the Energy and Environment pillar at Qatar Foundation Research and Development as of July 2017 after a period as program manager in its funding agency entity, Qatar National Research Fund (2015-2017). She spent the large majority of her career (1999-2014) serving the industrial private sector in large global corporations. In 2001, she joined the large steel company Tata Steel in the Netherlands as project manager in R&D for the global automotive market. Until November 2014, she occupied various leading positions in R&D managing research professionals, then groups and a department, in the fields of materials for surface engineering, coatings and corrosion protection, including for environment and renewable energy solutions. Responsibilities involved business strategy, strategic innovation, product and manufacturing processes, co-development with customers, and implementation of new technologies for the automotive, packaging and the building and construction markets. Those had led to commercial products and to customer recognition – e.g., Toyota award for the best R&D coating department among its competitors.

From 2004 to 2015, she served the European Federation of Corrosion as an elected member of the international scientific committee and has acted as chairman of the automotive section. From 2009 to 2014, she acted as a member of the technical committee on finishing and coatings of the RFCS (Research Fund for Coal and Steel) at the European commission. Recently, she was nominated as the director of the EFC Middle East Branch with its headquarters in Doha. She was a board member of Materials Engineering at the Institute of Applied Sciences (INSA Lyon) from 2007 to 2014. Since 2016, she has been a visiting professor at the CNRS Research Institute of Electronics, Microelectronics and Nanotechnology, Villeneuve d'Ascq (France).

She holds a master's degree in chemistry physics from the University of Burgundy (France) and a Ph.D. in industrial process engineering–material sciences from the Technical University of Compiegne (France) (1993) for the group Valeo. She took a postdoctoral position in the Institute of Applied Chemistry in Berlin in the field of catalysis, followed by a research fellow for BAE systems, Bristol R&D center in the UK where she developed corrosion prevention solutions for aluminum parts in aerospace applications. Since 2009, she has been acting as industrial expert for the European Commission in the graphene flagship, in EU-funded programs, including horizon 2020.

Corrosion Challenges in Gas Production and Processing: An Overview of Corrosion Research at Qatar Shell Research & Technology Centre

Dr. Nick Laycock
Senior Engineer and R&D Lead
Qatar-Shell Pearl GTL

Abstract

The Pearl asset in Qatar consists of two offshore platforms in the North Field, two subsea pipelines carrying gas to shore, and the onshore processing facility – the largest gas-to-liquid plant in the world. This paper will outline the corrosion management program at these facilities and describe some of the most challenging topics in more detail. The paper will also provide an overview of the Materials and Corrosion research program at QSRTC, which focuses on issues relevant to Pearl GTL but also of significant interest to the wider oil and gas community. For example, current projects include work on corrosion monitoring for wet sour gas pipelines and another project on advanced surface coatings for external protection in marine environments

Bio: Laycock is currently the senior materials and corrosion engineer for the Pearl GTL facilities and the corrosion R&D lead for Shell in Qatar. He joined Shell in New Zealand in 2006 and before that he was a researcher and consultant. He has been author of about 100 peer-reviewed papers and is on the editorial board of Corrosion Science journal. Laycock has an M.Sc. and Ph.D. from the Corrosion & Protection Centre at UMIST. He has received the Shreir Award (1994) and Hoar Award (1997 and 2011) from ICorr, and the Guy Bengough Award (2013) from the Institute of Materials, Minerals and Mining. Laycock's research aims to bridge the gap between fundamental mechanistic studies and practical engineering solutions. This leads to a particular interest in the understanding of complex corrosion morphologies and the development of improved methods for the prediction of long-term corrosion rates in real service environments. His main research areas have been the pitting corrosion of stainless steels, CO_2

and H_2S corrosion of pipeline steels, and the application of advanced statistical techniques in corrosion life prediction. Extensive collaboration with applied mathematicians and synchrotron science specialists has been a key feature of his career to date.

Reliability Modeling of Different Assets Based on Extreme (Corrosive) Environment: Trends and Opportunities

Dr. Homero Castaneda-Lopez
Associate Professor and Director
National Corrosion and Materials Reliability Laboratory
Texas A&M University, USA

Abstract

In this presentation different corrosion science and engineering areas are covered as current and past projects carried at NCMRL, where the main concept is to bridge the gap between fundamental research and technology by understanding the corrosion process and giving high value to the industrial sector. Different technological challenges will be addressed in this presentation for the understanding of the corrosion characterization, control and mitigation methods of several industrial applications. To address these challenges, we present different research approach by combining multiscale concept, electrochemical fundamentals and high-resolution experimental technology with deterministic and probabilistic mathematical tools into a comprehensive concept.

The Texas A&M National Corrosion and Materials Reliability Laboratory (NCMRL) is leading its research and technology efforts for materials degradation and reliability. Corrosion is considered the “$1 trillion problem” in the U.S., which by definition turns a natural process into a strategic area for mitigation and control actions and solutions. NCMRL focuses in research, development in corrosion science and engineering by providing materials selection, mitigation strategies, and life time prediction tools trough research, education, training and testing of materials.

Bio: Homero Castaneda is associate professor and director of the National Corrosion and Materials Reliability Center at Texas A&M University. He received his bachelor’s degree in chemical metallurgical engineering and his master’s degree in materials science from the National Autonomous University of Mexico in 1994 and 1997 respectively. He then earned his Ph.D. in materials science and engineering from Penn State University in 2001. Castaneda has 18 years of experience using electrochemical and nondestructive techniques to monitor interfacial phenomena in materials and theoretical modeling of corrosion processes for different industries. He has been the PI for multiple projects on corrosion science and engineering for the U.S. Department of Energy, U.S. Department of Defense, U.S. Department of Transportation and several companies. Before joining Texas A&M, he worked for five years at The University of Akron (2011 to 2015) as an assistant professor and was previously at Battelle Memorial Institute as a senior scientist (2006-2011) in the Advanced Materials and Pipelines Center in Columbus, Ohio. Before Battelle, he was the technical director of the Corrosion, Materials and Pipelines in the Mexican Petroleum Institute for five years. He has been author or co-author of more than 70 peer-reviewed papers in the areas of corrosion science and engineering, coatings degradation and reliability, materials characterization and electrochemical impedance spectroscopy. He has eight patents and copyrights. To this slate he adds a unique mixture of corrosion knowledge in offshore or similar settings including the standards and regulations pervasive in these fields. Castaneda has been appointed as a member for the Academy of Science and Engineering for the oil and gas components and in 2018 will receive the prestigious H.H. Uhlig Award in Corrosion Science and Engineering Education.

Relating the Crystallographic Character of Individual Grain Boundaries to Their Hydrogen Embrittlement Susceptibility

Dr. Michael Demkowicz
Associate Professor
Department of Materials Science and Engineering
Texas A&M University, USA

Abstract

Hydrogen embrittlement (HE) of metals has been known and continuously investigated for well over a century. Nevertheless, a steady stream of unexpected H-induced failures shows that HE is still far from fully understood. We integrate high energy diffraction microscopy and x-ray absorption tomography to create 3-D, non-destructive reconstructions of the morphology and microstructure of cracks in a specimen of Ni-base alloy 725 that had been tested to failure in tension after charging with hydrogen (H). We observe 10 instances of the crack path being deflected by individual grain boundaries, which appear to be especially resistant to H-assisted fracture. By investigating their crystallographic character, we find that all but one of them may be described as “boundaries with low index planes” or BLIPs: boundaries where at least one of the neighboring grains has a low Miller index facet ({001}, {011}, or {111}) along the grain boundary plane. These observations lead us to identify three toughening mechanisms in H-charged alloy 725: crack meandering, twin intersection-induced grain boundary toughening, and frictional sliding. Our findings shed new light on the factors contributing to fracture resistance of individual grain boundaries as well as grain boundary networks, enabling improved lifetime predictions of Ni-base alloys in H environments and guiding efforts to reduce hydrogen embrittlement susceptibility through microstructure design.

Bio: Demkowicz is an associate professor in the Department of Materials Science and Engineering at Texas A&M University. Before that, he was an associate professor in MIT's Department of Materials Science and Engineering. He received his Ph.D. in mechanical engineering from MIT in 2005, working with Ali S. Argon. During that time, he was an NSF Fellow. From 2005 to 2008, Demkowicz was a Director's Postdoctoral Fellow and technical staff member at Los Alamos National Laboratory. In 2007, he was honored with the LANL Postdoctoral Distinguished Performance Award. He received the TMS Early Career Faculty Fellow and NSF CAREER awards in 2012, and the MIT Graduate Materials Council outstanding teacher award in 2014 and 2015. He is an author of more than 100 peer-reviewed publications, with more than 2,000 citations and a Web of Science H-factor of 28. His interests focus on solid-state interfaces in metals, mechanical behavior, and radiation effects.

Materials for Extreme Conditions for Reduced Friction and Wear

Dr. Andreas Polycarpou
Professor and Head
Mechanical Engineering Department
Texas A&M University, USA

Abstract

Modern devices that include rubbing components are expected to meet higher performance requirements under extreme operating conditions, thus rendering traditionally low-cost materials and liquid lubrication ineffective. Tribology has emerged as one of the fields that contribute to the solution of environmental problems through the development of materials, products and solutions less hazardous or harmful to the environment. The air-conditioning and refrigeration industry, for example, has addressed this issue of greener technology shifting its attention towards advanced compressors that use environmentally friendly refrigerants and oil-less conditions. Similar cases are currently under investigation for oil and gas/energy applications. Under oil-less conditions, it becomes necessary to implement some type of advanced protective coatings on the interacting surfaces to withstand stringent rubbing conditions, including tribo-corrosion. Extreme operating conditions also include high to very high temperatures up to 1000oC. In this presentation, we present recent work using several polymeric-based high-bearing coatings, including PTFE-based, PEEK-based and a newly developed aromatic thermosetting polyester (ATSP) -based coating. Some of the ATSP-based coating systems exhibited almost zero wear under both dry and boundary lubricated conditions.

Bio: Polycarpou received his Ph.D. from the University at Buffalo. Before joining Texas A&M in 2012, he was the Wilkins Professor and associate department head at the University of Illinois, Urbana-Champaign. He was also the Founding Department Chair of Khalifa University (Abu Dhabi) from 2011-2012 while on leave from the University of Illinois. Before that, he was a postdoctoral fellow at the Technion and a staff scientist at Seagate Technology. Polycarpou's research interests include tribology, micro/nano tribology, nano mechanics, and advanced interface materials. Recent emphasis has been on micro/nanoscale contact problems with application to micro-devices, as well as the tribology of devices for reduced energy and improved environmental-related impact. Polycarpou is the author of about 200 archival journal papers, and numerous book chapters, volume proceedings, a dozen patents and conference papers. Polycarpou has won numerous national and international awards, including the ASME Burt L. Newkirk Award, the National Science Foundation Faculty CAREER Award, and the Xerox Award for Faculty Research, the STLE Edmond E. Bisson Award, a Fulbright Scholar, the ASME K.L. Johnson Best Paper Award and the STLE Walter D. Hodson Award. Polycarpou is active in the tribology and mechanics communities, where he has served in many posts, including chairing the ASME Tribology Division. He was also an associate editor for the ASME Journal of Tribology, serves on several editorial boards, and has organized numerous conferences, including being the chair of the 2009 International Joint Tribology Conference. Polycarpou is currently serving on several honors and awards committees, as well as the chair of the executive committee of ASME's Department Heads Council.

Graphene Composite-based Anticorrosion Coatings

Dr. Ahmed Abdala
Associate Professor
Chemical Engineering Program
Texas A&M University at Qatar

Abstract

Organic coatings are widely used to mitigate the deterioration of metals by acting as barrier between metal substrates and the surrounding corrosion environments. However, pores in organic coatings may network and create channels that permit corrosion species such as chloride, oxygen and moisture to diffuse to the interface between the protective coating and the metal substrate leading to acceleration of adhesion loss, coating blistering and metal corrosion. Therefore, incorporating fillers or corrosion resistant pigments can greatly enhance the corrosion resistance of organic coatings. In this presentation, we discuss the use of different graphene materials to enhance the performance of epoxy and polyetherimide coatings applied on copper, stainless steel, and cold rolled steel and tested under seawater environment. We demonstrate that small loading of pristine graphene, graphene oxide, or functionalized graphene oxide greatly enhances the anticorrosion characteristic of epoxy and polyetherimide coatings as demonstrated by the increase in corrosion protection, adhesion strength, impact strength, and thermal stability. The role of dispersion of the graphene nano-filler into the polymeric matrix on the coating performance will be elaborated.

Bio: Abdala is associate professor in the Chemical Engineering Program at Texas A&M University at Qatar. He was previously senior scientist at Qatar Environment and Energy Research Institute (QEERI) and associate professor at Hamad Bin Khalifa University (HBKU). Abdala received his Ph.D. in chemical engineering from North Carolina State University. After completeing his Ph.D., he joined Princeton University on a Postdoctrate Fellowship (2003-2004) before returning to his home country, Egypt, as assistant professor at Suez Canal University (2004-2006). In 2006, he joined the Petroleum Institute in Abu Dhabi as assistant professor, and was later promoted to associate professor (2011) and served as the deputy chair of the Chemical Engineering Department (2012-20014). Abdala's research focuses on development of advanced materials for energy and environmental applications based on polymers and carbon nanomaterials including polymer nanocomposites, functionalized graphene materials, anticorrosion coatings, polymeric membranes for gas separation and water treatment, and nanohybirds of metal oxides and 2-D carbon materials. He has published 47 peer-reviewed articles that have received more than 9,000 citations and been granted seven U.S. patents. Abdala is the recipient of the Qatar Excellence in Innovation Award for Citation Impact Classified by Web of Science from Thomson Reuters, in October 2016; the Science Lantern Faculty Award from Abu Dhabi National Oil Company (ADNOC) in 2013 and 2014; the Best Paper Award (First Prize) from Kuwait Foundation for Advancement of Science in 2011; and the Nancy G. Pollack Thesis and Dissertation Award for the best Ph.D. thesis in the College of Engineering from North Carolina State University in 2003.

Progress in the Stochastics Modeling of Pitting and Cracking in Stainless Steels Exposed to Oil and Gas Producing Environments

Dr. Raymundo Case
Professor of the Practice
Department of Materials Science and Engineering
Texas A&M University, USA

Abstract

To assess the susceptibility of series 300 stainless steels to stress corrosion cracking (SCC) under both sour and non-sour service conditions a stochastical model is developed. The model is based in the hypothesis that the critical conditions for crack initiation and propagation are satisfied by the presence of metastable pit regime. The transition from meta stable pit to crack for SCC follows using the slip dissolution model, in which the crack growth rate is controlled by the crack tip strain rate produced by the remote applied stress and can be described using the Cogleton's correlation considering the Tsujikawa criteria as a boundary condition. The results suggest that metastable pits that arise to produce SCC show a minimum frequency of pitting defined as:

$$\omega_0 \leq C_A i_0 \sigma^{\frac{3}{2}}$$

In this expression, CA is a material related constant. Thus the likelihood of metastable pit propagating into cracks is controlled by the pit propagation time ($\tau0=1/\omega0$) that based on experimental evidence, follows a probability distribution function described as:

$$P(n;t) = \frac{(\lambda t)^n e^{-\lambda t}}{n!} \quad \textbf{where} \quad \lambda = \omega_0 P_{Cracking}$$

The probability of cracking Pcracking is evaluated using the Tsujikawa border condition in conjunction with crack propagation algorithm1 . The forecasting for time to failure is assessed from the elapsed time to achieve sustained crack growth using the hazard function derived from the pit survival probability distribution function. The next step on the study is to model the pit propagation time ($\tau 0$) in terms of the pit incubation time (τpit) and survival (τs) following the description of the pitting as a stochastic birth-death process. In this context, τpit can be obtained from the characterization of the passive layer using point defect modeling (PDM) and τs from the modeling of the pit growth and stability.

Bio: Raymundo Case is a materials scientist with 30 years of experience in materials selection, fitness for service and corrosion control in the oil and gas industries. He obtained his Ph.D. in corrosion science from UMIST, UK, in 2002, working on localized corrosion of corrosion resistant alloys in sour producing environments. During his career, he has been author or coauthor of more than 35 publications in peer-reviewed journals and proceedings, as well as a reviewer for several corrosion and electrochemical journals. He received the 2016 Technology Award from NACE International and the 2013 Technological Achievement prize from Conoco Phillips.

Smart Autonomous Systems for Pipeline Defect Detection

Dr. Mansour Karkoub
Professor
Mechanical Engineering Program
Texas A&M University at Qatar

Abstract

The oil and gas industry operates and maintains thousands of miles of pipelines consisting of steel and cast iron pipes to transport crude and natural gas throughout the world. The steel oil/gas mains are prone to time dependent defects such as corrosion, cracks, and dents which can reduce safety and security of service and threaten the environment if failure occurs. Inspection plays a key role in the integrity management of pipelines which led to the wide use of “smart pigs” to inspect pipelines internally. Smart pigs have since been improved to be able to detect cracks, coating disbandment, dents, and gouges as well. However, they suffer from several drawbacks that reduce their usefulness in some situations and render them useless in others: (i) Smart pigs are unavailable for small-diameter pipelines and for pipelines with varying diameters; (ii) They are unable to pass through smaller-diameter valves; (iii) They are non-autonomous and require for operation a medium with differential pressure; (iv) They create disturbances in the medium flow. Smart pigs use a technology known as magnetic flux leakage (MFL); however, there are other Nondestructive Evaluation (NDE) techniques, eddy current (ET), acoustics, and ultrasonics (UT) that can be used for the inspection of the walls of energy pipes. All of these techniques are, in fact, used in pipeline inspection. However, the number of techniques becomes more restricted depending on whether the inspection is performed inside (internal) or outside the pipe (external) as well as whether it is performed in the field or in a laboratory setting. Magnetic Flux Leakage techniques have the advantage of higher sensitivity for embedded defects, relatively fast detection, very robust and insensitive to specimen’s surface cleanliness.

Accurate and efficient pipeline inspection is extremely important to the oil and gas industry and it is usually carried out either internally using smart pigs and

tethered robots or externally with limited inspection options. Here, we discuss a novel design for an autonomous robot for pipeline external inspection as well as future research directions in offshore and onshore external pipeline inspection as well as automation of the process using autonomous underwater vehicles (AUVs) and robotic propulsion systems.

Bio: Karkoub is a professor of mechanical engineering at Texas A&M University at Qatar. He received the B.S. in mechanical engineering with highest distinction in 1984, M.S.M.E. in 1990, and Ph.D. in 1994, all from the University of Minnesota, USA. In 2003, Karkoub received an HDR (Habilitation to Direct Research) from the University of Versailles, France. He held faculty positions at Kuwait University, the Petroleum Institute, and the French Research Institute in Informatics and Automation. His research interests include robust control, robotics, mechatronics and vibration engineering. Karkoub has published more than 150 peer-reviewed articles and authored a textbook, *Tools for Design Engineers*, published by the Academic Publishing Council (APC). He has raised more than $11 million in research funds, including $8 million during the past seven years, developing smart solutions for the oil and gas industry dealing with the integrity of oil and gas infrastructure. Karkoub designed and constructed an industry go to drill rig for vibration control and drill-bit-rock interaction characterization, which attracted additional funding of $1.1 million in 2017 from the oil and gas industry. He is the founder of the smart systems lab at Texas A&M at Qatar, which houses state-of-the-art equipment ($2 million award value), including, AGVs, AUVs, ROVs, and mobile platforms. Karkoub is a registered Professional Engineer in the state of Texas; a fellow of ASME, the Institute of Mechanical Engineering and the Institute of Engineering Technology, and a Senior member of IEEE.

The Role of Emerging Grain Boundary at Iron Surface on Metal Dusting Initiation

Dr. Fadwa Elmellouhi
Senior Scientist
Qatar Environment & Energy Research Institute
Hamad Bin Khalifa University, Qatar

Abstract

Despite significant advances achieved in the preparation of high-quality metallic surfaces, surface defects such as vacancies, dislocations and emerging grain boundaries at the surface are inevitable. These defects affect the homogeneity of the surface by enhancing its catalytic activity and favoring the adsorption and segregation of impurities and molecules that might trigger corrosion. Density functional theory calculation were carried out using 158 Fe atom system representing emerging ∑3 GB on (111) free surface. A larger system of thousands of atoms was simulated using the cost effective ReaxFF molecular dynamics (MD) implemented in LAMMPS package to control the insertion of hundreds CO and H_2 molecules. Simulations were performed on both clean and defective iron surfaces containing grain boundaries emerging at the surface with a groove as V-shape at the center of the sample. We simulate dissociation and formation of CO, H_2O, H_2, OH and CO_2 molecules on thousands of atoms iron surface models that allows us to obtain metrics on the number of CO molecules dissociated, carbon atoms reacted with surface and new molecules formed. The present work contributes to the general understanding of the very early stages of the metal dusting corrosion initiation at very short time and length scales unveiling aspects hardly accessible experimentally. This work is supported by the Qatar National Research Fund (QNRF) through the National Priorities Research Program (NPRP10-0105-170118 and NPRP 6-863-2-355). The advanced computing facility of Texas A&M at Qatar was used for all calculations.

Bio: El-Mellouhi is a senior scientist at the Qatar Environment and Energy Research Institute. She obtained her Ph.D. from Université de Montréal in 2006 and her diploma in 2001 form the Abdu Salam International Center of Theoretical Physics in Trieste, Italy. El-Mellouhi's research is in the field of computational materials science and design applied to photovoltaics, fuel cells, batteries and corrosion. She uses electronic structure calculations, various energy landscape exploring methods coupled with force fields, as well as Kinetic-Monte Carlo modeling. She also has interest in high-performance computing, computer-aided discoveries and science outreach. She is involved in the development of promising simulation programs aimed to study problems long outside of the reach of computer simulations, such as nanocluster formation, nanostructure growth, corrosion, alloying and interfaces in metals. Before joining QEERI in early 2014, El-Mellouhi was assistant research Scientist Texas A&M University at Qatar. She was previously a postdoctoral researcher in the physics department of Université de Montréal. She has numerous peer-reviewed publications, as well as scientific and outreach national and international talks.

In-situ Thermomechanical Corrosion Fatigue Testing

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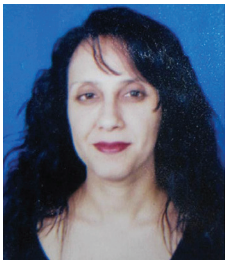
Abstract

This work aims to provide insights into the synergistic effect of thermal cycling and corrosion on the fatigue behavior of materials. The samples were prepared in a "C-ring" shape, employing different manufacturing and surface modification treatments that distinctively affect the surface characteristics and microstructure, having a different impact on their effective life-span. A novel in-situ thermal-cycling, corrosion and fatigue device, able to produce cyclic thermal and mechanical loadings in an alternating corrosive solution was developed and employed in these investigations. One test case was the investigation of the corrosion-fatigue behavior of as-machined (wire-EDM), blasted and anodized aluminum alloy 7075-T651 using 3.5wt% NaCl aqueous solution and distilled water as corrosive media. Blasting process offered a prolongation of the corrosion-fatigue life-span in both corrosive media, when compared to the as-machined samples under identical conditions. Anodizing had a deleterious effect in all the examined cases. A second test case material was a high temperature NiTiHf-based shape memory alloy (HTSMA), which is supposed to be among the potential users in aerospace, automotive and energy exploration industries. Large actuation capability, broad range of transformation temperatures and stable responses are some of the requirements in most of these applications. Understanding the failure mechanisms and fatigue of NiTiHf-based HTSMAs is a challenging, still unexplored task. The first results show that due to the intrinsic recoverable deformability of the surface-originating martensitic transformation, a complicated failure mechanism is revealed.

Bio: Michailidis is professor and director of the Physical Metallurgy Laboratory (PML) in the School of Mechanical Engineering at Aristotle University of Thessaloniki (AUTH), Greece. He studied mechanical engineering at AUTH and received his Ph.D. from the same school. He is currently president of the Hellenic Metallurgical Society (HMS); chair of the Centre for Research and Development in Advanced Materials, a joint initiative between Texas the A&M Engineering Experiment Station (TEES) and AUTH; chair of the Design and Construction Division in the School of Mechanical Engineering, AUTH; and founder of PLiN Nanotechnology SA, AUTH's spin-off. He served as research affiliate at the Fraunhofer Project Center Coatings in Manufacturing (2008-2015) and as visiting professor at the Fraunhofer Institute for Production Technology (IPT) in Aachen, Germany (2008–2009). He is a member of various scientific societies and boards, and associate member of the International Academy for Production Engineering. His scientific interests are related to porous materials, coatings manufacturing, rapid prototyping, nanoparticles production, fatigue and stress-corrosion cracking of smart materials.

He was awarded a fellowship by the SEW Euro-drive Foundation in Germany in 2008 and has received various other awards, including the AUTH Excellency Award in 2017 and the AUTH Excellency and Innovation Award in 2008. He has coordinated 43 and participated in 80 research projects funded by various international/national and industrial partners. He has published 125 papers in international peer-reviewed journals, 360 peer-reviewed conferences, three book chapters, and in three encyclopedias. His research work has received 2,692 citations with an h-index of 30 (Google Scholar).



Failures in Qatar's Oil and Gas Installations Due to Atmospheric Corrosion

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Abstract

Very few oil and gas installation locations in the world experience sustained high humidity and high temperature for long periods of the year as is experienced in Qatar. For example, the humidity in Qatar readily reaches 90 percent and the summer temperature, measured on metal surfaces, can reach 80oC. In addition, Qatar's proximity to the high salinity Arabian Sea enhances the build-up of salts that contain aggressive species such as chloride on the metals' surfaces. This is complicated by sand storms which leave contaminated sand particles on the surfaces exposed to this environment. All these factors plus the temperature fluctuation make atmospheric corrosion a major challenge in oil and gas installations in Qatar. This paper reviews the atmospheric corrosion issues that are encountered in these installations, provides examples for failures, and discusses the efficiency of the current corrosion protection methods that are used in Qatar.

Bio: Farhat is a mechanical engineering instructor at the College of the North Atlantic-Qatar and a lead corrosion engineer managing Qatar Petroleum's Corrosion Atlas Phase II research project. Farhat has a bachelor's degree in materials and metallurgical engineering from Tripoli University in Libya, and a master's degree and Ph.D. in mechanical engineering in corrosion engineering from the University of Saskatchewan, Canada. Farhat is a member of NACE and ASME, as well as the ISO standards technical committee (TC 67) and the International Association of Oil and Gas Producers. She was one of the founders of the Forum for Materials Technology in Qatar and is currently the forum chairman. She has more than 20 years of experience in the oil and gas industry in Qatar and internationally. She previously worked as a materials engineer, inspection engineer, senior RBI engineer, lead corrosion engineer and a technical service manager. She holds several certifications from API, NACE and

NDT Level III certifications. Her main area of interest is atmospheric corrosion, environmentally induced cracking. She has been performing root cause failure analysis, corrosion, and fitness-for-service studies to the oil and gas companies in Qatar since 2013, and has written more than 80 technical reports. She is currently involved in several corrosion studies and failure analysis for oil and gas companies in Qatar and is working in field and simulated field research studies with Qatar Petroleum

Corrosion Work in the Centre for Advanced Materials, Qatar University

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Abstract

The corrosion work in the Centre for Advanced Materials at Qatar University will be overviewed. The work funded by QNRF and industry in Qatar (including Qatalum, Qatar Shell, Qatar Petroleum, Qatar Gas and Qatar Electricity and water Company) in the corrosion science and engineering field will be highlighted. The presented topics will include underdeposit corrosion study, effect of minor alloying elements in carbon steel on the carbonates scales formation rate (experimental and modelling study), failure analysis cases in different industrial sectors in Qatar, atmospheric corrosion in seven different locations that represent a variety of environments.

Bio: Abdullah started his work at Qatar University in 2012. He is currently the Hydro/Qatalum Chair Professor in the Centre for Advanced Materials. In 2003, he was awarded his Ph.D. from The Pennsylvania State University, USA, in materials science and engineering. In addition, he worked at Tokyo Institute of Technology, Japan, between 2006 and 2009, followed by one year at The University of Calgary, Canada. From 2010 to 2012, he joined the Chemical Engineering Department at the Egypt-Japan University of Science and Technology, Egypt. Abdullah's research interest is mainly on the electrochemical science and technology – e.g., corrosion science and engineering (atmospheric corrosion, scales formation and inhibition, under deposit corrosion, localized and uniform corrosion mechanisms and inhibition), microelectrodes and sensors, PEM and solid oxide fuel cells catalysts and durability, super-capacitors, mesoporous and super-hydrophobic materials, and photocatalysis for water treatment.

Rehabilitation of Corroded Sheet Piles Quay Wall at Old Doha Port (Realistic Case Study)

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Abstract

The research has been prepared on behalf of the Public Works Authority – Design Department, with the main objective to undertake technical assessment and recommend a way forward to rectify defects for the existing Corroded Sheet Piles Quay wall at Old Doha Port of approximated length=116m and retained height above seabed level = 10m. It was recommended to make rehabilitation for the corroded sheet piles quay wall using the guidelines for the method statement of remedial and renovation works as briefly explained in the research to limit construction risk, increase design life, minimize maintenance and enhance the visual appearance of the structure. For complete assessment of the corroded sheet piles quay wall, the following process had been applied: 1-Patterns of corrosion along sheet piles were identified along with splash zone, tidal zone, low water zone, and immersed zone; 2-Careful re-analysis was established. To determine the exact capacity at the section with maximum thickness loss, which may not have been the critical section originally analyzed; 3-The remaining service life based on allowable stresses, stability and safety were determined for the purpose of treatment feasibility study. The effective methods to treat and prevent corrosion were controlled through the application of the following methods of treatment: welding plates over holes and thin/damaged areas, protective coatings over corroded areas, and cathodic protection.

Bio: Shaykhon works as advisor in the design engineering department at Publish Works Authority “Ashghal.” His technical experience spans more than 30 years with 17 years acquired in the Gulf region for both private and public sectors. He has fully conversant expertise in the structural design, consultation and construction processes from inception to completion for large-scale projects, such as towers (50+ stories), tunnels, airports, hospitals, schools, stadiums, harbors, malls, hotels, mosques, and military projects. Arbitration: reports for technical judgment. Appraisal: reports for rectification, remedial and renovation works. He also has six years of university teaching experience in line with program goals to meet the needs and aspirations of the student and community. During his service he worked on many iconic health care, education, sporting, aviation, marines, and civic, residential, commercial, military and energy projects.