CorrDefense DoD News about Preserving Military Assets

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Top Story

Universities Explore the Merits of Collaborating With DoD

In our Fall 2011 issue we explored how the Corrosion Policy and Oversight Office plans to more closely align the research goals of military corrosion experts with those of university scientists. To manage this, the Corrosion Office has raised the stakes of the Technical Corrosion Collaboration (TCC) program, a four-year-old partnership involving nine universities. This is the second of a two-part Q and A panel exploring the goals and objectives of the new TCC program.

In the discussion below, CorrDefense Editor at Large Cynthia Greenwood asked scientists representing TCC's five universities and four military academies how well their research in corrosion science and engineering lends itself to collaboration with military labs and other universities. Each addressed how their institution is uniquely poised to advance the field of corrosion prevention and the TCC program. *(See Researchers Discuss How Their Goals are Aligned with the TCC.)*

Represented on the panel are TCC members Luke Brewer (Naval Postgraduate School); Gerald Frankel (The Ohio State University); Lloyd Hihara (The University of Hawaii); Shankar Mall (Air Force Institute of Technology); Joe Payer (The University of Akron); James Rawlins (The University of Southern Mississippi); Joel Schubbe (U.S. Naval Academy); John Scully (The University of Virginia); and Gregory Shoales (U.S. Air Force Academy).

CorrDefense: What strengths and unique technological specializations does your institution bring to the Technical Corrosion Collaboration (TCC)?

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Gerald Frankel (The Ohio State University): Our primary strength is our excellent students. For decades the students of the Fontana Corrosion Center have made major technical contributions in their thesis work here at OSU and then gone on to positions of leadership in industry, government, and academia. Technically, we are strong in the areas of localized corrosion, inhibition, surface treatments, protective coatings and coating adhesion, atmospheric corrosion, stress corrosion cracking, and modeling of corrosion damage accumulation.

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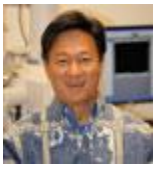
Joel Schubbe (U.S. Naval Academy): We have several individuals here at the Naval Academy (including Professor Pat Moran) who are longtime corrosion experts. We have extremely well developed facilities here, including environmental chambers, surface profilometers, scanning electron microscopes, and optical microscopy. In addition, there is a wealth of fatigue testing equipment. Many military labs have access to this equipment at other sites, but not always on a regular basis. We also have a very solid group of students who are interested and excited about independent research.



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Lloyd Hihara (University of Hawaii): The Hawaii Corrosion Laboratory at the University of Hawaii is involved in corrosion research of traditional and advanced materials, syntheses of advanced hybrid ceramic-polymer coatings, and the development of corrosion technology. Research is conducted in a facility with corrosion, electrochemical, microscopy, and analytical capabilities. The Hawaii Corrosion Laboratory has also developed and maintains 10 outdoor test sites representative of various microclimates and environments such as dry, rainforest, alpine, agricultural, light industrial, mild and severe marine, and volcanic (with acid rain). A major goal of ours is to understand the correlation between electrochemical testing, accelerated corrosion testing, and performance in natural environments.

Shankar Mall (Air Force Institute of Technology): AFIT, located at Wright-Patterson Air Force Base, engages in research activities that enable the U.S. Air Force to maintain its scientific and technological edge and dominance. Biaxiality loading has dramatic effects on crack growth behavior and fatigue life, and its effects have been investigated within long cracks in ambient environments. However, the effects of biaxiality loading conditions are not known on crack formation and growth from corrosion pitting in different environments. AFIT's role in the TCC is to investigate the biaxiality loading effects on corrosion fatigue, and none of the current partners in TCC has such capability in terms of test facilities and expertise. In addition, AFIT's close proximity to and interaction with scientists from AFRL's (Air Force Research Lab's) Materials and Manufacturing and Air Vehicles Directorates bring new dimensions to the collaboration. AFIT's research also involves the U.S. Naval Academy.

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Luke Brewer (Naval Postgraduate School): We focus on the effect of microstructure and microchemistry on the corrosion of structural alloys. In particular, my group focuses upon the interplay between mechanical stresses and corrosion, which can lead to stress corrosion. For example, we are using x-rays to measure the residual stress around welds in aluminum to better predict the onset of stress corrosion cracking in marine aluminum alloy structures. In addition, we are exploring the use of cold spray deposition technology as a means of repairing stress corrosion cracking damage in ship and aircraft structures. We are particularly interested in developing in-field diagnostic and repair technologies. A special capability of NPS students is their ability to access Navy ships anytime, which helps those of us on the faculty who are Navy civilians. Because our students work in DoD, we usually have direct access to people who work in the shipyard.

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Joe Payer (The University of Akron): At UA we have a long-established structure of people and facilities supporting corrosion science and technologies. UA's strengths include an orientation in corrosion risk management focused on greater safety and reliability, the engagement of outside experts to work with our core of corrosion engineering faculty, and the active participation of undergraduate students from a wide range of engineering specialties and sub-specialties on research projects.

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James Rawlins (The University of Southern Mississippi): Among the TCC members, we at USM focus on applied research. We specialize in conducting applied research in polymeric materials, which makes our work closer toward the needs of the end user. We also have coating formulation expertise and significant research experience on material behavior and structure-property relationships. This experience helps us interact positively with material suppliers to the DoD.

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Gregory Shoales (U.S. Air Force Academy): As a TCC partner we happen to be an unusual hybrid-we're an undergraduate institution with a robust research arm, and we are also a DoD lab known as CAStLE (Center for Aircraft Structural Life Extension). At CAStLE, we examine how corrosion impacts the integrity of aircraft structures. How are corrosion and cracking inter-related, and how do they operate separately? In essence, we are trying to encourage the sustainment community to move past the tendency to isolate experts in corrosion from experts who manage cracks, because it's not appropriate to consider the effects of one damage mechanism without the other. As I already stated, CAStLE has developed a number of short courses on failure analysis and bonded repair of aircraft structures. We also have corrosion content in our standard curriculum, and we're always looking for ways to make that more robust. Since CAStLE's inception and thanks in part to the TCC, our scope has expanded beyond aircraft to include our national infrastructure issues.

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John Scully (The University of Virginia): UVA has a number of distinct strengths and other strengths that overlap with our TCC partners. Professor Gangloff's strength is researching the link between fracture behavior and the environment, along with understanding the metallurgy, and this can involve analysis of sophisticated forms of corrosion such as static load or cyclic load cracking. I study corrosion-metallurgy interactions beyond surface corrosion, including hydrogen embrittlement among other phenomena, which results from corrosion in some environments. Hydrogen is very difficult to measure, and at UVA we have some unique hydrogen quantification tools that other universities don't have. In addition, Professor Kelly has expertise in areas relating to chemistry on surfaces and surface chemistry evolution during atmospheric exposure. There's certainly overlap in the TCC partners' specialties. The Air Force and UVA are both strong in environmental

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fracture; Ohio State and UVA are strong in corrosion-metallurgy, and these strengths are complemented by USM's strength in polymer science.

***CorrDefense*: How well are the military labs suited to help your institution develop, implement, and apply its most important research?**

Scully (UVA): Before Dan Dunmire and Rich Hays set up the TCC, there were a limited number of laboratory personnel in the DoD labs to accept the research that we could hand off. But now, under the current collaboration there are a number of military labs that can collaborate as well as receive the research and information we can offer. Although some of the things that we regard to be grand challenges in corrosion aren't necessarily the same unsolved mysteries that the military labs have, the TCC helps UVA define some of their high-priority needs and unanswered questions. Through the TCC, we're able to channel our strengths and bring them to bear on the DoD's most important issues.

Rawlins (USM): The military divisions that still have laboratories are very well suited to integrate with what we do at USM's School of Polymers and High Performance Materials. Recent collaborations have begun with the U.S. Air Force Academy and Army Research Lab. At USM, we're fortunate to have the drive, passion, and work ethic to generate meaningful results with multi-year funding. Until now, our researchers have engaged at all levels with some TCC university or DoD partner involving coatings, sensors, and other types of technology exchange. As we aim to meet the TCC's upcoming goals, I think you'll see virtually all USM researchers engaged with somebody at a DoD lab.

Mall (AFIT): Our students are Air Force officers and civil contractors as well as Army and Navy officers. All student research studies are sponsored by various DoD agencies, and most are conducted in very close collaboration with AFRL scientists. Several material scientists, a non-destructive evaluation engineer, and an aerospace structure analyst from AFRL are collaborating on our current, TCC-sponsored corrosion research project at AFIT. As part of this collaboration, scientists from the Materials and Manufacturing and Air Vehicles Directorates of AFRL have already provided several useful and practical suggestions. This research effort is already steered, due to this interactive close collaboration, in a direction whose results will be incorporated into AFGROW (Air Force Growth). AFGROW is widely used by the Air Force and its contractors to analyze crack growth behavior from localized corrosion sites in aerospace structures under realistic loading conditions, a phenomenon that is a major cause of structural damage or, in certain instances, catastrophic failure.

Brewer (NPS): The NPS projects funded through the TCC started in October 2011. We partner quite heavily with the DoD labs, especially the Navy. Right now we're working with the Naval Surface Warfare Center (NSWC), Carderock, on a project involving the stress corrosion cracking of aluminum, which is providing research opportunities for students working on their master's theses. The TCC's goal of furthering collaborations between academia and DoD suits us well because we are a primary source of graduate school education for active-duty military officers, as well as DoD civilians. All of our master's degree candidates must do research-based coursework and a research-oriented thesis, which supports and extends the TCC goal. As the majority of our students are active-duty officers, we have an eye for how research can be applied directly to the needs of the Defense Department.

Shoales (USAFA): USAFA has been involved in the TCC for several years. CAStLE has not only been here to support our cadets, but since 1995 we've had a history of providing science and technology support to the Air Force sustainment community, specifically the people in the Air Logistic Centers who maintain our aircraft. Our TCC partnership also has our cadets and research engineers collaborating with other universities in the DoD corrosion program. Over the last 15 years CAStLE has focused on delivering solutions to our customers—the USAF users and the warfighters. What makes us unique within the TCC is that our research is focused on product delivery to our customers. At the same time we serve the educational mission of the TCC because of our Center's integration into the engineering academic department. Regardless of the source, we always look to extract relevant elements of research programs for infusion into the USAFA cadet curriculum through projects ands course content.

Frankel (OSU): We at OSU have had very good relationships with some of the military labs, in particular the Air Force Research Lab, the Army Research Lab, NAVAIR (Naval Air Systems Command) and NAVSEA (Naval Sea Systems Command). These collaborations have taken several forms, and all have been helpful to our work. One form of interaction occurs when military lab personnel provide advice to our projects through their deep practical knowledge. This helps us keep focused on issues of relevance. Another type of collaboration involves a problem that is encountered at a military lab but requires more time and focus than can be committed in that environment. In the university setting we can address such issues and bring understanding that helps DoD experts in their work. A final form of interaction is where an idea generated in our lab is further developed into practice in the military lab.

Schubbe (USNA): I see the TCC initiative as a combination of deep knowledge experts and broadly experienced individuals scattered throughout the labs and here at the U.S. Naval Academy, AFIT, AFRL, ONR (Office of Naval Research), and ARL (Army Research Lab). Because researchers in my department are funded through a variety of laboratory sources, program offices, and NAVAIR, the DoD divisions are an excellent source of ideas and practical applications that foster our areas of interest. I am specifically interested in fatigue and fracture, but I've recently branched out into environmentally assisted cracking and the corrosion aspects of metallics that go into aircraft and ship structures. Using funding through NAVAIR and the F-18 Program Office, I've also looked at ultrasonic test methods and the degradation of composite-oriented materials. I see the labs as being critical to what we do. Over the past five years, I've gotten most of my funding either through program offices, through NAVAIR, or through NRL. Other professors working on corrosion issues get funding through NRL, ONR, and some of the Air Force research institutions.

Payer (UA): The military labs are well suited to play a crucial role in the DoD/university collaboration. They have subject-matter expertise in a number of science and technology areas, as well as remarkable equipment and facilities that further productive collaboration. Until the TCC formed four years ago, a major barrier to DoD and university partnerships was a mutual lack of awareness and a functional vehicle for collaboration. The DoD Corrosion Office's TCC program addresses both of these earlier impediments.

Hihara (UH): Interaction with personnel from various DoD laboratories and facilities has allowed us to focus our research on relevant topics. We have not yet utilized any military laboratory facilities in our research, but would be interested in pursuing this if the opportunity arises.