Department of the Navy SBIR/STTR Transition Program

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Topic # N13A-T007

Development of Atomistically-Informed Peridynamics Framework for Corrosion Fatigue Damage Prediction

Advanced Cooling Technologies, Inc.

WHO

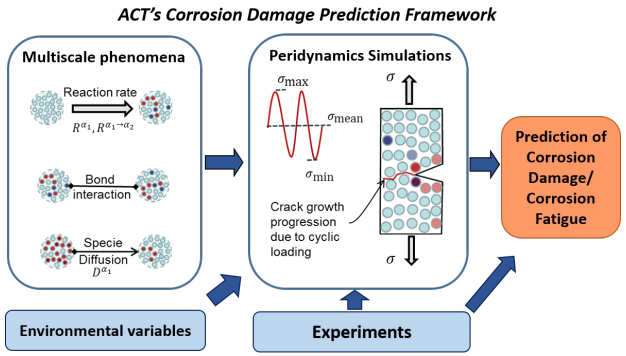
SYSCOM: NAVAIR

Sponsoring Program: Navy and Marine Corps' Helicopter Program Office PMA-299

Transition Target: Tilt-rotor Aircraft PMA 275, and other rotary wing aircrafts

TPOC:
(301)342-0297

Other transition opportunities: Corrosion is an omnipresent problem which can cause dangerous and expensive damage to defense assets, aircrafts, automobiles and civil infrastructure. The simulation toolkit under development will provide a theoretical/computational means to evaluate the airworthiness of aircraft and facilitate timely checks and maintenance schedules to improve the lifetime of the aging fleet. Program offices which deal with aging defense systems such as: the Light/Attack Helicopter Program Office (PMA 276), V-22 Osprey Program Office (PMA 275), MH-60R/S Multi-Mission Helicopter Program Office (PMA 299).



WHAT

Operational Need and Improvement: Corrosion related damage remains a major challenge in aging Navy aircraft fleet and infrastructure, with adverse implications on both operational safety and ownership costs. A major concern is corrosion fatigue (CF) damage caused by synergistic actions of corrosion and mechanical stress, which significantly affect aircraft component durability and integrity. Traditional tools for estimating CF damage are based on analytical models and yield large uncertainties in service environments. A new physics-based modeling tool is needed for improved corrosion damage prediction.

Specifications Required: Multiphysics corrosion fatigue theory will be developed using peridynamics approach across length and time scales relevant to Naval aircraft. The computational models must underpin the true physical processes rather than empirical correlations. The model should also minimize computational resources and time requirements.

Technology Developed: The peridynamics-based multiscale reactive framework will accurately model the CF damage phenomenon in response to environmental conditions and mechanical loading cycles. This technology will enable efficient simulation of crack-propagation and failure without the need to crack algorithms or re-meshing . It will also enable the development of a unified corrosion prediction toolkit for predicting corrosion damage phenomena (e.g., CF, stress corrosion cracking, Hydrogen-embrittlement) and its influence on naval aircraft components exposed to different corrosive environments during their service life.

Warfighter Value: Accurate CF damage quantification is likely to enable timely checks and maintenance operations, thereby improving the readiness-level and operational safety of naval infrastructures. With the increasing number of 'aging' aircrafts in service, the developed tool can facilitate adoption of a "predict and manage" philosophy rather than the current "find and fix" paradigm, and will result in significant cost-savings for the fleet.

WHEN

Contract Number: N68335-15-C-0032 **Ending on:** July 20, 2016

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Develop a mechanistic peridynamics framework	N/A	Proof of concept of corrosion physics	2	December 2014
Develop unified corrosion damage prediction framework	Low	Model analysis and capture of corrosion physics	3	December 2015
Peridynamics based simulation of corrosion fatigue phenomena	Low	Model predicitability and simulation results	4	March 2016
Verification, validation and calibration	Low	Ability to prediction damage in different settings	5	July 2016

HOW

Projected Business Model: ACT intends to license the computational software toolkit to customers, which may be DoD end-users or corrosion maintenance and prevention engineers. Technical services in the form of software development, verification, validation and consulting will be provided to the end-user community. Strategic partnerships will be formed to add-on new enhancements to the computational suite (e.g., different material-environment combinations) and for validation.

Company Objectives: ACT is looking for organizations interested in solving their corrosion prediction needs through physics-based modeling and prognostics. Potential partners for development and validation efforts are being sought for the integration of our toolkit into engineering design processes and corrosion-based aircraft/infrastructure maintenance and repair (scheduling) tools.

Potential Commercial Applications: The technology is of interest to prime defense manufacturers who design systems for helicopters, aircrafts, defense equipment which deal with corrosion related issues and comprises of components subject to fatigue, creep and/or impact loads. One possible application could be to investigate the influence of environment and mechanical loads on the extent of corrosion related damage experienced by the components in these systems at design stage. Such a design stage analysis could lead to significant design improvements for prime defense manufacturers like Lockheed Martin, Boeing, Northrup Grumman etc., who design aviation fleet, aircraft fleet and defense systems exposed to corrosive sea-atmosphere.

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