The DOD estimated that the annual cost of corrosion, the unintended material degradation due to the environment, to weapon systems and infrastructure in 2010 exceeded $21 billion, and that the number is likely to continue to rise [1]. Corrosion affects military readiness by taking critical weapon systems out of action, due to the degradation of equipment. Unfortunately, as the warfighters demand more from their systems, corrosion prevention and control is frequently traded during the acquisition cycle for weapon system performance. As a result, the DOD remains entrenched in a *find-and-fix* corrosion management philosophy which is expensive and unsustainable.

At the same time that the DOD is operating at a higher operations tempo in harsh environments, activities are underway to move away from hexavalent chromate as a corrosion inhibitor [2]. Chromate is an excellent corrosion inhibitor, however it poses great health risks and therefore the DOD would like to eliminate its use. SAFE Inc. is working to document the effect chromate has on corrosion fatigue damage under government cooperative agreement FA-7000-11-2-0011. This body of data will allow for proper comparison of newer chromate-free coatings to the previously used chromate coatings. In turn this will give the DOD a better understanding to challenges facing current corrosion mitigation systems which will provide life-cycle clarity and improved prediction models.

As chromate coatings are being phased out, accelerated testing of currently approved chromate replacement coatings could greatly help the DOD select and design better coatings for protection against corrosion fatigue damage in a post-chromate operating climate. The ability of chromate replacement coatings to protect against corrosion damage has not been documented at all with respect to fatigue. An improved understanding of how environment, polymeric coating properties, and loading parameters influence a coating's ability to offer protection against corrosion fatigue damage would greatly help the coating community to design more robust coating protection systems. Work has been proposed to the Office of Naval Research (ONR) to start the examination of the chromate replacement coatings on fatigue damage (ONRBAA14-001), this proposed work would leverage the work proposed to ONR to have a greater body of data on DOD approved coatings.

The current work (FA-7000-11-2-0011) has led to an AFRL SBIR (F141-164-1704) to develop an accelerated corrosion fatigue test method to better replicate real world corrosion conditions. Current corrosion testing uses qualifications like the ASTM B117 salt fog test and MIL-SPECS (MIL-DTL-53022, MIL-DTL-53030, MIL-PLF-23377 etc.) for surface damage evaluations. Full immersion of fatigue samples in corrosive solutions are used for testing inhibitor effects on fatigue crack propagation. Often these laboratory test environments are not representative of atmospheric corrosion. Most structural corrosion occurs because of hydrated salt layers, affected by pollution and other local environmental conditions, on the structure surface. Demonstrating these types of environments in a laboratory setting is a complex process because the salt layer can be very environmentally specific and the corrosion morphology produced can be changed by the presence of ultraviolet (UV) light, ozone and the other contaminants present. This atmospheric corrosion methodology can greatly benefit the corrosion coatings community as it allows for an understanding of how the environmental exposure can change the coating leaching properties.

In recent years there has been a significant interest in Supersonic Particle Deposition (SPD, also known as Cold Spray) for structural repair (SR) and dimensional restoration (DR) of aircraft structures. Despite the initial upfront non-recurring engineering, SPD is a promising technology with many benefits.

- Extremely high density and compaction of deposited material
- No thermally induced residual stresses
- Minimal or no surface preparation required
- A wide selection of coating materials, including dissimilar materials
- Ability to custom-build the chemistry of multilayer deposits
- No generation of toxic gases, radiation, or undesirable chemical reactions
- Waste powder can be recycled
- Operates under normal temperature, pressure, and humidity conditions
- Well-defined localized coatings with near-net shape characteristics
- The shape of the deposit can be predetermined by the nozzle geometry.

In developing (SPD) corrosion repairs, whether low or high pressure process are being used, engineering development is required per damage scenario to determine the optimum process parameters; carrier gas pressure, carrier gas temperature, stand-off distance, gas velocity, particle velocity, particle properties, composition particle size/characteristics, feed rate, and surface preparation. These process parameters affect coating bond strength, cohesion, microstructural characteristics, and mechanical properties which then control the durability, damage tolerance, and corrosion performance of the repair.

Application of the SPD process for protective coatings and DR have been cited extensively in the literature. The Army, Navy, and Air Force are currently using or investigating SPD for DR, but none are using for SR. The primary issue with SR is the interface integrity. We will focus on improving the process parameters such that the SPD to base material interface provides no reduction in static strength, fatigue, or corrosion performance.