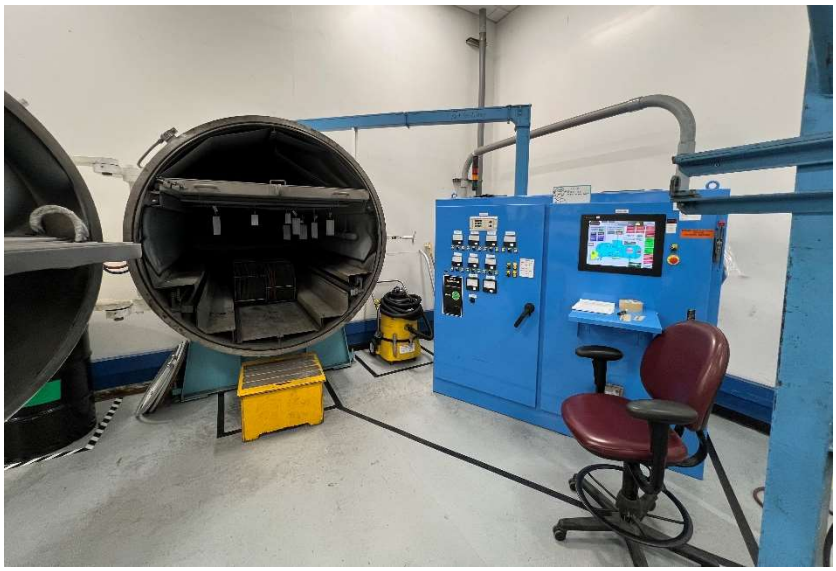
PROJECT ID:
634

Aluminum Conversion Coating Materials as a Trivalent Chromium Post-Treatment for IVD and Cadmium Coatings



Ion Vapor Deposition (IVD) vacuum chamber is used for the application of aluminum coatings onto substrates which result in higher temperature resistance and a safer alternative to hexavalent chromium coatings. (Image Credit: Kaitlyn Elkins)

OBJECTIVE

The objective of this effort is to develop optimized processing parameters and establish best practices for trivalent chromium post-treatment alternatives to cadmium electroplating and/or ion vapor deposition (IVD) aluminum coatings. The goal is to demonstrate performance equal to traditional chromium-based processes, enabling the transition to more environmentally friendly chemical chemistries.

PROBLEM STATEMENT

Aluminum IVD and Cadmium Electroplating require post-treatment processes to passivate their metallic surface and improve corrosion resistance and paint adhesion. Current post-treatment processes require hexavalent chromium and cadmium compounds, known carcinogens, and Occupational Safety and Health Administration (OSHA) and National Institute for Occupational Safety and Health (NIOSH) exposure recommendations have called for reduction and/or avoidance of these chemicals.

DESCRIPTION

This project aims to validate environmentally friendly alternatives to hexavalent chromium (hex-chrome) post-treatments currently used to protect and enhance adhesion of ion vapor deposition (IVD) aluminum and cadmium coatings on aerospace components. IVD coatings are applied via a vacuum process depositing high-purity aluminum, which requires a hex-chrome post-treatment to form a protective oxide layer that prevents corrosion and improves primer adhesion. Similarly, cadmium coatings are electroplated onto steel substrates and treated with a sodium dichromate-based post-treatment to extend service life and promote paint adhesion.

Due to the environmental and health concerns associated with hex-chrome and its temperature sensitivity (maximum 140°F), the project is evaluating trivalent chromium conversion coatings (specifically QPL-81706 Class 1A Type II) as hex-chrome-free alternatives. These coatings demonstrate higher temperature resistance and potentially enable process improvements, such as performing hydrogen embrittlement relief baking after post-treatment, reducing processing time and handling.

A color-enhanced trivalent chromium coating developed under NESDI Project #514 (Chemeon's eTCP) will also be evaluated for its ability to provide visual confirmation of post-

treatment application, facilitating quality control and maintenance inspections.

In Year 1, coated test coupons will undergo rigorous testing at Naval Air Warfare Center Aircraft Division (NAWCAD), including corrosion resistance, primer adhesion, and visual inspection, benchmarked against hex-chrome controls.

In Year 2, selected candidates will be scaled up and demonstrated on scrap components at partner facilities. Successful demonstrations will support formal authorization by NAWCAD Technical Warrant Holders (TWHs) and culminate in a final project report. This effort will enable the transition to safer, more efficient post-treatment chemistries while maintaining or improving protective performance and regulatory compliance.

RETURN ON INVESTMENT

Switching to trivalent chromium post-treatment for cadmium and IVD aluminum coatings offers significant cost, environmental, and operational benefits. It reduces permitting, health monitoring, hazardous waste disposal, and regulatory compliance costs, while improving worker safety. Replacing six tanks across the three Fleet Readiness Centers (FRCs) could cut procurement costs by about 50% and lower utility expenses, as the process runs at room temperature. Additionally, the shift mitigates future supply chain risks tied to the EU's REACH phase-out of hexavalent chromium.

NAVY BENEFITS

Implementation of the trivalent chromium conversion coatings in lieu of hex-chrome post-treatments can be instituted across the Naval Aviation Enterprise (NAE), with the primary benefit occurring at FRCs. This transition will facilitate the reduction in heavy metal exposure for artisans during application and coating removal, in addition the costs associated with disposal, hazmat regulations and fines, personal protective equipment, and personnel's occupational health monitoring will decrease across Naval facilities.

TRANSITION DESCRIPTION

The alternative post-treatments being demonstrated are already available as commercial products for aluminum conversion coatings and have a robust procurement network of companies and distributors, along with NSNs. Provided products meet performance benchmarks, then transition and implementation can be conducted seamlessly. Navy implementation can be widespread to D-level facilities where IVD and Cd are applied and post-treated on components, in addition to I and O-level repair activities, where post-treatment can be reapplied to damaged in-service components prior to reapply organic protective coatings (e.g., primers and topcoats).

MIL standard and Local Process Specifications (LPS) updates will allow for supplemental treatments and processes not containing hexavalent chromate and to reflect the new post-treatments allowed for IVD and Cadmium coatings.

CONTACT

For more specific information about this project, contact the Principal Investigator at joshua.g.walles.civ@us.navy.mil.

ABOUT THE NESDI PROGRAM

The Navy Environmental Sustainability Development to Integration (NESDI) program is the Navy's environmental research and development demonstration and validation program, sponsored by Office of the Chief of Naval Operations (OPNAV) Compliance and Mission Readiness Division (N4I1) and managed by the Naval Facilities Engineering Systems Command (NAVFAC) from the Engineering and Expeditionary Warfare Center (EXWC) in Port Hueneme, CA.

The mission of the NESDI program is to support Fleet readiness by minimizing operational constraints associated with environmental and human health risks and to reduce cost of environmental compliance by demonstrating, validating, and integrating innovative technologies, processes, materials, and by filling knowledge gaps.

For more information, visit the program's web site at www.navfac.navy.mil/nesdi
or contact the NESDI Program Managers at NESDI.fct@navy.mil