Non-Chromated Technology Works on Aircraft

Laura Roberts & Anthony Galanis

A major goal for the aerospace industry is to reduce and eliminate the use of chromates. Efforts for pollution prevention by the U.S. Environmental Protection Agency (EPA) through Executive Order 12856[1] identified the need to reduce the release of chromates during aircraft coating applications.

One of the most historically pervasive uses of materials containing chromate is in the treatment of aluminum with chromate conversion coatings (CCC) and chromated primers (CP) (Fig. 1) in aircraft coating applications. The CCC process prepares aluminum for the application of paint and also provides a corrosion barrier. Chromic acid from CCCs account for approximately twice the chromium waste as chromate primers while repainting aircraft.[2] Environmental, safety and health risks associated with the use of hexavalent chromium are being reduced and eliminated through different systems, using partial chrome or total non-chrome technology.

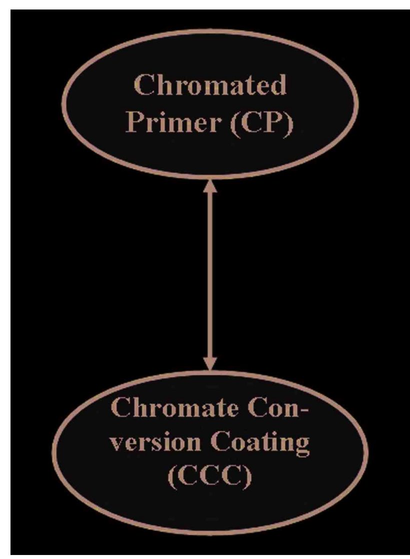

Figure 1

Replacements for Chromated Conversion Coatings

Replacements can be divided into two categories—non-chromated conversion coatings (NCCC) and non-chromated surface pretreatments (NCSP) that do not convert the substrate (Fig. 2).

Initially, both of these non-chromated replacements for the CCC looked promising, because they reduced the chrome waste by two-thirds, as opposed to only a one-third reduction when replacing the chromated primers.

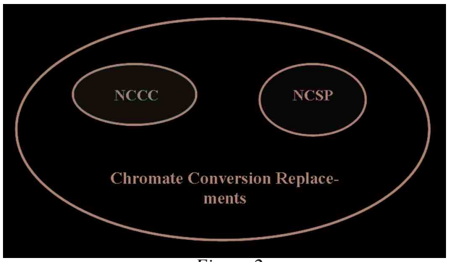

Figure 2

Non-Chromated Surface Pretreatment

As a response to environmental concerns, in 1996 the Department of Defense (DoD) began testing replacements for chromate conversion coatings as a safer alternative.[3] Four products were tested—three were non-chromated conversion coatings (NCCC), and one was a non-chromated surface pretreatment (NCSP). Surprisingly, within six months of the DoD's testing efforts, only one of the four evaluated products, the proprietary NCSP*, tested successfully as a suitable replacement for CCC. The NCSP product also eliminated other hazardous chemicals including etchants, solvents and alkali washes. Testing of the proprietary NCSP technology has included flexibility, filiform corrosion, adhesion and the 2000 hour salt spray on painted panels, yielding performance that surpassed the standard chromated methods (Fig. 3).[4] The first F-16 fighter plane was painted in 1997 and the test was complete in 1998, showing excellent results from the proprietary NCSP. In 2000, the Technical Order (TO) for repainting F-16s was changed to include specifications to use the NCSP. Since that time, more than 800 F-16s have been painted with the proprietary process, and the planes have been deployed all over the world, most recently for utilization in Iraq.

In 1996, the U.S. Air Force (USAF) began testing the product on T-37s and T-38s, with the first plane fully painted using the proprietary NCSP technology the same year. In 2001, testing was complete and the TO was changed to authorize the use of the product as a NCSP. Currently, more than 100 T-37s and T-38s have been painted using the NCSP technology. There are several USAF testing programs still underway. In 2000, a five year testing program was started with two C-130s and two A-10s, with the goal of possibly adding the proprietary NCSP to TO 1-1-8, the general technical order, which will authorize the use of the product on any USAF plane. Testing also includes using the technology on magnesium wheels and exterior missile silos,[5] both showing positive results.

***PreKote SP, Pantheon Chemical, Inc., Phoenix, ,AZ**

The U.S. Air Force started testing the product in 1996.

To date, not a single aircraft has been returned to depot for a paint or corrosion related issue. The early aircraft have completed their six-year cycle and are returning to depot for standard maintenance overhaul. Currently, all F-16s and all training aircraft are engaged in using a NCSP, along with 16 U.S. Air Force bases. The proprietary NCSP technology contributed to the USAF eliminating numerous hazardous products, as well as saving on disposal costs.

With the NCSP, finishers required less time to prepare, monitor and paint the aircraft, reducing personal protective equipment and other chromium-related requirements. The product is not EPA regulated under 40 CFR 433 and can be used on substrates including aluminum, magnesium, cadmium, steel, composite materials, anodized and non-anodized metals. The technology is not a conversion coating, does not permanently change the surface of the substrate, and is designed to be an integral part of the coating system.

Surfaces treated with the product cannot pass a 168 hour salt spray corrosion test. The NCSP is not designed to be used as a stand alone product, but rather in conjunction with a coating. NCSP treated panels that have been painted perform as well or better as a system when compared to panels that

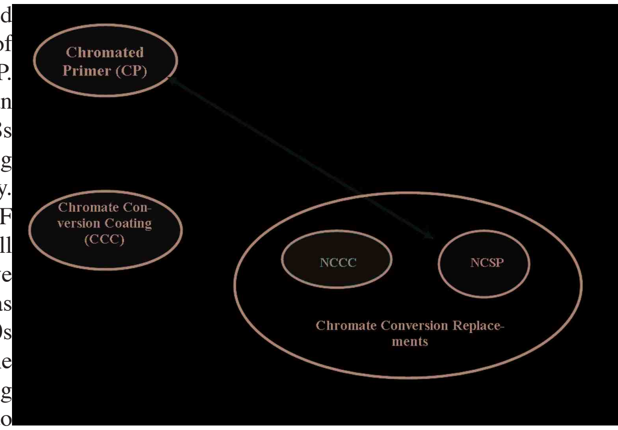

Figure 3

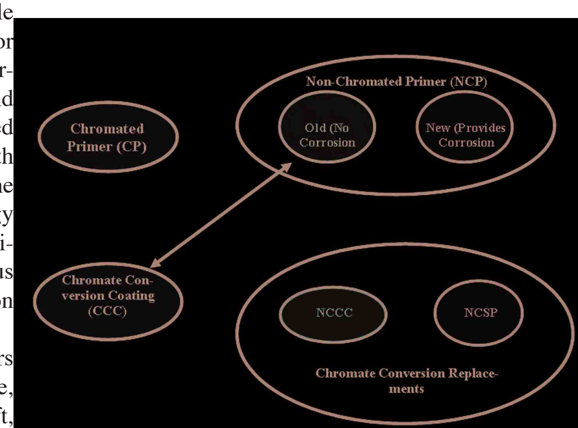

Figure 4

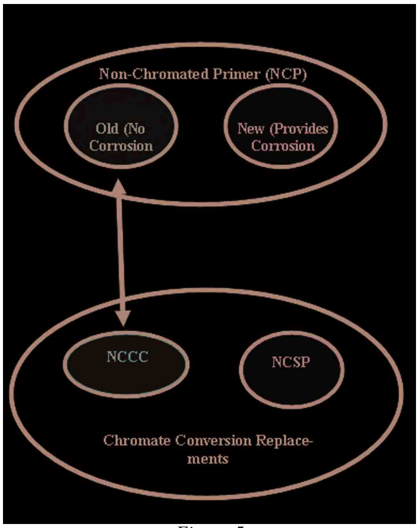

Figure 5

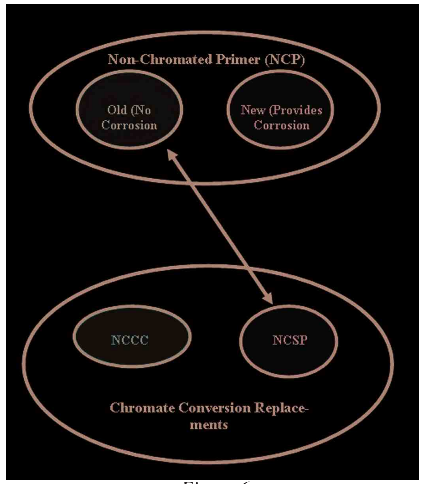

Figure 6

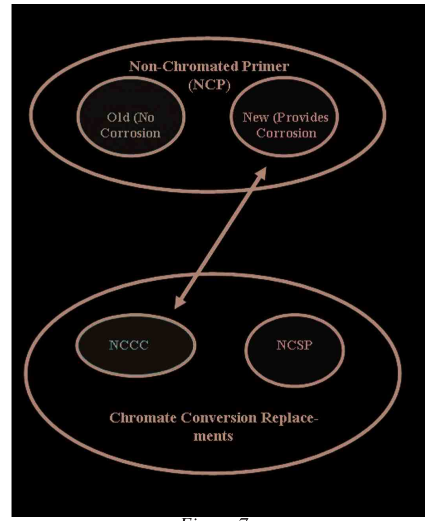

Figure 7

have been prepared with CCC and painted, including a 3000 hour salt spray test. Identified by the EPA as pollution prevention technology, its report concluded that the proprietary NCSP product reduces worker exposure to solvents and other toxic chemicals traditionally used in the painting operation.[6]

Based on all of the accumulated success with the non-chromate technology, USAF contacted the EPA Water Division for clarification on the metal finishing effluent guidelines (40 CFR 433) and how they pertain to use of the proprietary product. The report states that because the product is not a chemical conversion coating, the use of the product does not automatically trigger categorical industrial user status under the metal finishing effluent guidelines.[7] This is significant, because the guidelines are time consuming and costly to administer and follow. Other reports have found that the NCSP generates about half of the amount of wastewater as compared to the wastewater previously generated.[8]

USAF performed a time analysis study for all aircraft prepared using the NCSP process in 2001. This study showed a time savings of 35 percent per aircraft.[9] In addition to time savings, the Joint Group for Pollution Prevention (JGPP) estimates a cost avoidance of up to $2.23 per square foot of surface area treated just by eliminating the chromic acid.[10]

Non-chromated Primers (NCP)

First generation non-chromated primers (NCP) were designed to be used in conjunction with the chromate conversion coating (CCC). Because the chromates in the CCC provided the majority of the protection, these first NCP, by themselves, required little corrosion protection. There were successes with this combination, and this system did reduce chrome waste by one third. However, it still generated hazardous waste from numerous sources, and is still regulated under 40 CFR 433. (Fig. 4).

Chrome Free Systems

In the effort to completely eliminate chromates in aircraft painting, NCCC were developed and tested with the early NCPs. In theory, the NCCC would provide the needed corrosion protection as well as eliminate chrome waste, however, finding systems with this combination has proven difficult. In addition, any chemical conversion is still regulated under 40 CFR 433. Hazardous waste can also still be generated during the application of the NCCC. As with the CCC, the NCCC is restricted to specific substrates by nature of the conversion. This makes it difficult to find a system that can be used on the entire aircraft (Fig. 5).

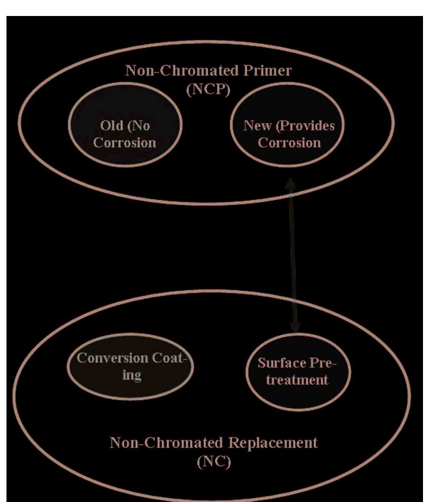

Figure 8

Another attempt was to combine non-chromated surface pretreatments (NCSP) and early generation NCP. However, because NCSPs do not convert the substrate, and are not designed to work with the older generations of non-chromated primers, there were no successes. The NCSP relies on superior adhesion and flexibility, as well as the corrosion inhibiting properties of the paint system, to successfully protect the substrate. It was not until recently that a new generation of NCP was developed that provided equal corrosion protection to the original chromated primers (Fig. 6).

This new generation of non-chromated primers NCP was introduced and tested with both the NCCC (Fig. 7), and the NCSP (Fig. 8). Although the chrome waste was eliminated in both, the success of the new non-chrome primers and non-chromated conversion coatings was minimized because of the inherent limitations of the NCCC system (*i.e.*, restricted to specific substrates, generates hazardous waste, still regulated, etc.).

The combination of the new NCP and the NCSP is proving to be a viable total non-chrome solution for the industry. This system combines the corrosion efficiency of the new generation of NCP, with the flexibility, adaptability and safety of the proprietary NCSP. Extensive laboratory and recent field testing has been showing that this complete non-chrome solution provides ample corrosion protection and superior paint adhesion. In addition, it is not regulated under 40 CFR 433, can be used on most substrates and does not contain any chrome waste or generate additional hazardous waste (Fig. 8). Success with NCSPs is paving the way for the industry to begin shifting to total non-chromated systems.

Total Non-chrome Future

A recent development in the non-chromated primers has exhibited an ideal non-chrome paint system. Not only is the system passing extensive laboratory testing but it is also being field tested. Information on this system can be obtained from the authors. *P&SF*

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Since 2000, more than 800 F-16s have been painted using the NCSP technology.

About the Authors

Laura Roberts is chief executive officer of Pantheon Chemical Company, 225 West Deer Valley Road, No. 4, Phoenix, AZ 85027, 1-888-608-7888. Since 1999, Roberts has engineered an extensive reorganization of the company to include development of its management team, protection of its intellectual property, automation of its manufacturing operations, definition of its markets, and articulation of its sales and distribution strategy. She currently directs the company's business operations and investor relations activities.

Previously, she designed and conducted a comprehensive five-year market analysis of the aerospace industry that confirmed the need and desirability for use of non-chromated processes in painting aircraft.

A *summa cum laude* graduate of Northern Arizona University with a degree in social and behavioral sciences, for two consecutive years she enjoyed the distinction of being the University's highest ranking scholar.

A member of the AESF Greater Arizona Branch, Roberts serves on the Board of Overseers of the Hospitality Industry Hall of Honor, and is a member of the Arizona Tooling and Machining Association and the Arizona Manufacturer's Network.

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Galanis is a veteran of 11 years in the U.S. Navy Nuclear Program. He served on the USS Parche, the USS Henry M. Jackson and the USS Florida, all of which are in the U.S. Nuclear Submarine Force.