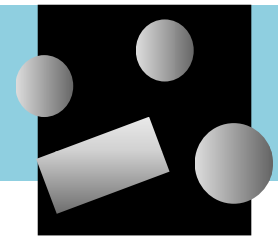


# Nanomaterials for Coatings



## FUNCTIONALIZED NANOPARTICLES

### APPLICATIONS

- Non-chromate corrosion inhibitors
- Biocidal additives
- Non-skid coatings
- Platicizers
- Enhanced wear and abrasion resistant coatings

### INNOVATION

- Particles can be tailored to specific application requirements.
- Versatility of surface modification allows dispersion into many coating types including water-borne, solvent-borne, and high solids.

### BENEFITS

- Low loading requirements
- Corrosion inhibitors performance equivalent to chromates
- Made from non-toxic precursors

## NEW NANOPARTICLES DEVELOPED BY TDA RESEARCH, INC. FOR ADVANCED COATING PROPERTIES

TDA Research has developed a new class of nanomaterial additives for coatings. These materials are surface modified to design in specific property improvements. Nanoparticles can be tailored for a variety of applications including as chromate-free corrosion inhibitors, biocidal additives, and non-skid coating additives. These nanoparticles are versatile, and can be used in many different coating types (epoxies, polyurethanes, and latexes).

## Non-Chromate Corrosion Inhibitors

The corrosion of metals has widespread economic and environmental effects for the U.S. The annual cost of corrosion to the U.S. was estimated at \$276 billion dollars. Corrosion is also a serious issue for the Department of Defense; it is the number one cost driver in life-cycle expenses, costing the DoD approximately \$20 billion per year. To date hexavalent chromates are the most effective corrosion inhibitors; however, they are carcinogens and regulations will soon prohibit their use in most coatings.

Until now, no chromate-free corrosion inhibitor has performed as well as heavily loaded chromated primers. Recently, TDA has developed nanoparticle based, organic corrosion inhibitors that are highly effective and chromate-free. These nanoparticles have organic corrosion inhibitors anchored to the surface that are triggered to release by the corrosion process. While anchored, the corrosion inhibitors are non-leachable, but when released they migrate to arrest corrosion at the metal surface. These materials provide excellent corrosion resistance in epoxy primers on high strength aluminum alloys. The nanoparticles performed as well as chromate materials in both a 3,000 hour salt fog tests and the even more difficult 1000 hour filiform corrosion tests. TDA is currently investigating chromate free low-VOC epoxy primers and polyurethane fuel tank coatings.

Alodine 1200/ 0.5 % Nanoparticles    Alodine 1200/40% Chromate    Alodine 1200/20% Halox SW 111

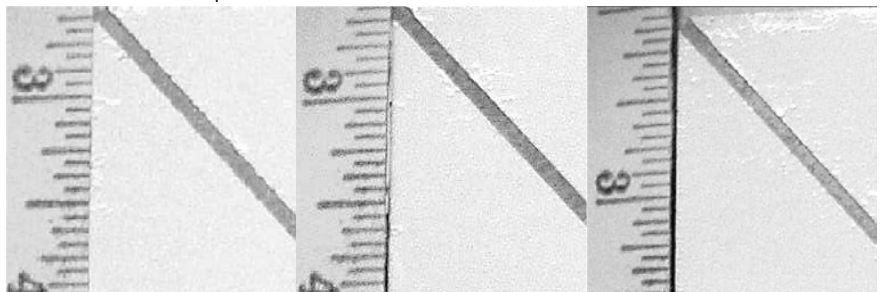


Figure 1. Nanoparticle coating (left) matches performance of soluble chromates (center) and exceeds performance of strontium phosphate silicate (right) in 1000 hr filiform test on Al-2024.



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## Biocidal Coatings

Architectural coatings – which account for over 50% of the volume of the U.S. coatings market – incorporate biocidal additives are critical to delay attack by algal and fungal growth. These biocidal coatings kill microbes and fungi by slowly and steadily releasing biocide from the dried film. Unfortunately, this mechanism is also responsible for the ultimate deactivation of the biocidal activity; once the biocide has leached out or washed out of the coating, all protection against microbes is lost. Typically, the biocidal activity lasts only around 18 months, and even less in hot, humid environments like the Southeast United States. Once the biocides have leached out, a new coating must be reapplied to regain antifungal protection.

TDA Research is developing a new biocidal coating system that prolongs biocidal activity by immobilizing biocidal additives on a nanoparticle. With TDA's advanced nanoparticle technologies, the embedded biocides are designed to release into the environment only as needed, thus extending the lifetime of the biocidal activity. These imbedded biocides eliminate the undesired contamination of the surrounding area and stay within a coating longer.

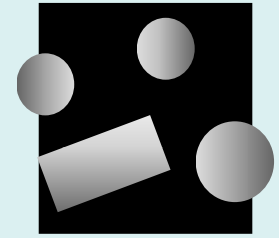
## Non-Skid Coatings

Non-skid coatings are an important safety feature on aircraft where maintenance operations and aircraft boarding involve walking along the wings. Current non-skid treatments are generally organic coatings mixed with large additives such as sand or plastic media that make the surface rougher. This approach has many drawbacks, including increased weight and aerodynamic drag. The extremely rough surfaces are also difficult to clean.



Figure 2. V22 Osprey; Falling is a major safety concerns during exterior maintenance, which requires walking along the wing.

TDA Research has developed an advanced low-drag non-skid coating using specifically designed nanoparticle friction additives. These coatings are light weight with low drag and match the non-skid performance of 80-grit sandpaper. In addition our technology allows us to incorporate the nanoparticle friction additives directly into the coating formulation. In most traditional non-skid treatments the grit is broadcast onto the still wet paint and rolled into the paint, because it would settle out if mixed within the paint. TDA's additives can be pre-mixed and the paint can easily be applied by spraying or brushing with no additional work needed after paint application. These non-skid coatings can be used to coat military airplanes on those areas that need higher traction without increasing the airplane weight or damaging the performance of the topcoat. This technology has been fully tested in house and is currently being evaluated at Boeing, Bell Helicopters and U.S. Navy. It is expected to enter the Navy qualification process in 2005.



## TDA Research, Inc

Established in 1987

Today employees 65 people including 60 scientists and engineers

\$10 million annual revenue

## OUR BUSINESS

Perform contract R&D

Patent inventions (63 current and pending patents)

Commercialize technologies by

- Internal business units
- Spin-off companies
- Licensing agreements

## FOR ADDITIONAL INFORMATION

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Research