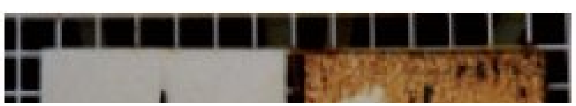
More Than A Temporary Corrosion Covering

More Than a Temporary Corrosion Covering - chemically bonded phosphate ceramics

Chemically Bonded Phosphate Ceramics create a passivation layer that stops corrosion, protected by a tough ceramic outer layer explains Del Williams, a technical writer based in Torrance, California.

Corrosion of steel, aluminum, and other structural metals erodes the safety and financial stability of industries and countries alike. Fighting corrosion in ships, tanks, planes and equipment costs the Pentagon $22.9 billion a year. Corrosion costs advanced industrialised nations about 3.5% of GDP to replace damaged material and components, plus a similar amount due to lost production, environmental impact, disrupted transportation, injuries, and fatalities.

While traditional corrosion protection has relied mostly on short-lived physically-bonded coverings of substrate surfaces, a new category of Chemically Bonded Phosphate Ceramics (CBPCs) can create a long-lived passivation layer that stops corrosion. This is further protected by a tough ceramic outer layer.



Ceramic coating under test conditions - corrosion only occurs on the scribe line

The limits of traditional corrosion protection

For generations, polymer paints have acted as a physical barrier to keep corrosion promoters such as salt water and oxygen away from steel and aluminum substrates. This works until the paint is scratched, chipped, or breached and corrosion promoters enter the gap between the substrate and polymer coating. Then the coating can act like a greenhouse—trapping water, oxygen and other corrosion promoters—allowing corrosion to spread.

Placing sacrificial, reactive elements next to steel that will corrode first, such as zinc and galvanized coatings, is another strategy. This works until the sacrificial elements are used up and recoating must be done, usually after a few years.

Cathodic protection, where a negative voltage is imposed on steel, can limit corrosion on pipelines or other stationary, continuous metal structures where voltage can be attached. But this can fail if it's not properly insulated and voltage goes to ground.

For assets that demand long-term corrosion protection, stainless steel alloys work. But with stainless steel costing up to six times more than mild steel, this option is often cost prohibitive.

A new approach to corrosion protection

Ideally, engineers, facility managers, and industrial paint contractors would want the long-term corrosion-resistance of a stainless steel part with the lower cost of coating application. A new category of CBPCs is now making this possible.

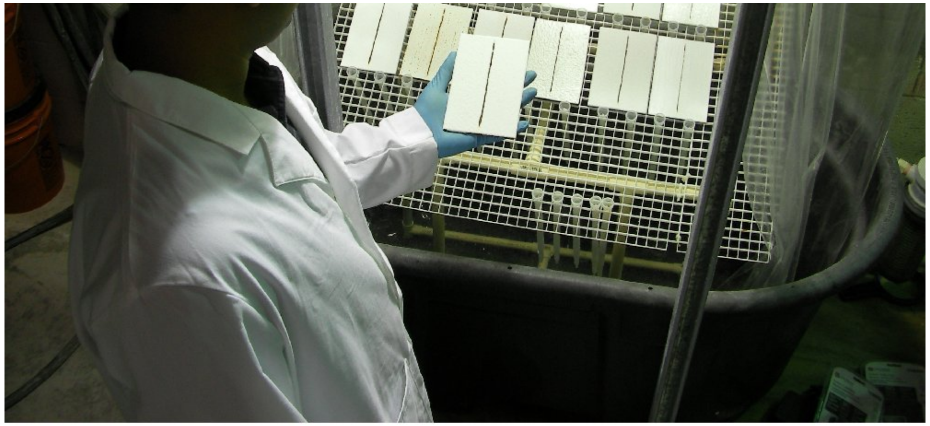
“Unlike polymer paints that simply cover a substrate, CBPCs essentially ‘alloy’ the surface,” says Tony Collins, CEO of EonCoat, based in Wilson, NC.

Dr. Arun Wagh, a former materials engineer at Argonne National Lab, and lead developer of the technologies underlying the new ceramics, explains it like this:

“When a dual-component spray gun mixes an acid phosphate with base minerals and metal oxides in a water slurry, a chemical reaction occurs on the surface of the steel substrate,” says Wagh. “A hand-held thermometer indicates a 10-12 °F temperature rise, as iron becomes a corrosion-resistant passivation layer of iron oxy hydroxide. Because the passivation layer is electrochemically stable, like gold and platinum, it does not react with corrosion promoters such as water and oxygen.”

Scanning electron microscopy indicates this passivation layer is about 20 microns thick. X-ray diffraction indicates this passivation layer is about 60% iron with components of phosphate, magnesium, silicon, hydrogen, and oxygen.

“History suggests that the new coating’s passivation layer may resist corrosion indefinitely, as demonstrated by the Iron Pillar of Delhi,” says Wagh. “The Iron Pillar, a 7-meter high, 6-ton Indian artifact that has resisted corrosion for 1600 years with its original inscriptions still legible, has a virtually identical passivation layer to that of the coating.”



Experts at the NASA research center helped the manufacturer design a side-by-side corrosion test comparison of the EonCoat ceramic and other high-performance coatings.

In contrast to typical paint polymer coatings which sit on top of the substrate, the new coating bonds through a chemical reaction with the substrate, so slight surface oxidation actually improves the reaction.

Though CBPCs have proven themselves in the laboratory and in examples such as the Iron Pillar, Tony Collins knew that the effectiveness of the new material had to be compared to that of traditional anti-corrosion coatings.

Duplicating a NASA corrosion test, Collins immediately put the new coating to the test against 19 leading anti-corrosion coatings in a live corrosion test, viewable to the public by webcam at www.eoncoat.com. Coated samples were scribed, then exposed to 12 hours of sea spray, followed by 12 hours of sunlight (or the UV light equivalent). After 45 days, every other high-performance coating tested failed. Except for the rust on its scribe (gouge) line, the new coating sample looked the same as day one.

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