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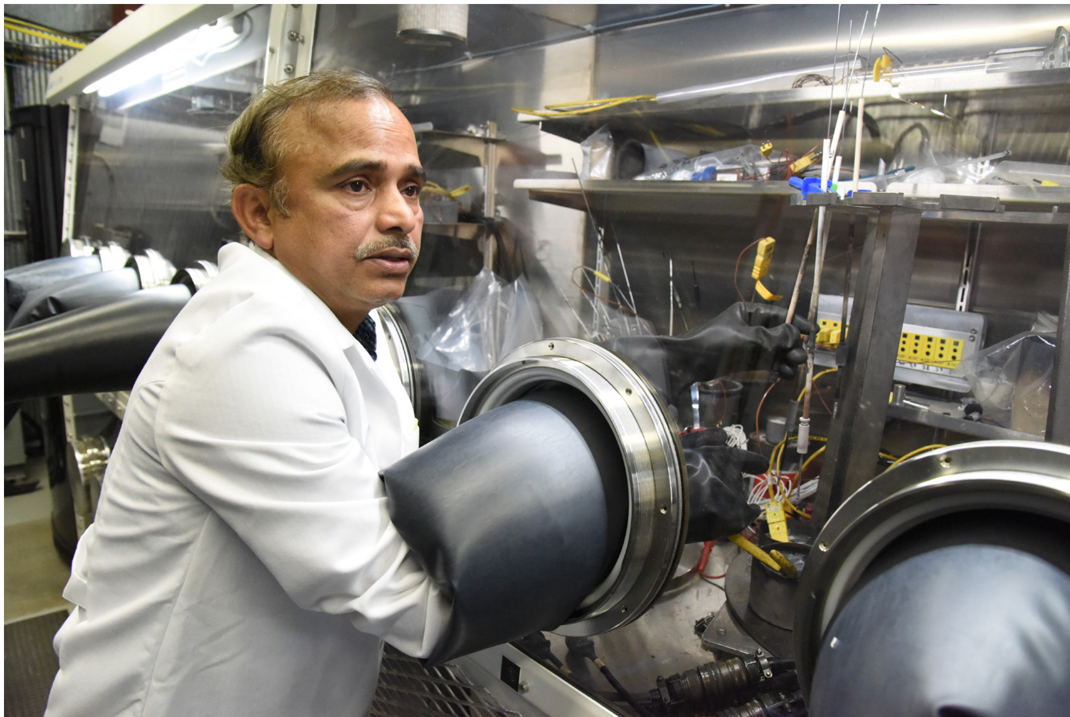

The Energy of Innovation

INL Idaho National Laboratory

Aluminum electroplating using bromide salts

Creating Stronger, Longer-lasting Protection Against Corrosion

Technological Marketing Summary

Corrosion of structural materials is a serious problem for industrial and civil infrastructure worldwide, costing billions of dollars and hampering gross domestic product. In its 2016 report, "International Measures of Prevention, Application and Economics of Corrosion Technology (IMPACT)," NACE International (founded in 1943 as the National Association of Corrosion Engineers) estimated the global cost of corrosion to be $2.5 trillion (USD), equivalent to roughly 3.4 percent of the global GDP. The study found that implementing corrosion prevention best practices could result in global savings of between 15 and 35 percent of the cost of damage, up to $875 billion (USD). Corrosion also presents a threat to the environment and public safety, with highways and bridges losing structural integrity and hazardous materials leaching into soils, waterways and aquifers.

At Idaho National Laboratory, researchers have developed electroplating processes involving bromide salts that result in thick, uniform and smooth metallic aluminum coatings. While chloride-based plating baths have been widely used to electroplate aluminum onto steel, brass, copper and other substrate materials, the drawbacks include lack of ability to form a diffused aluminum layer between the metal surface and aluminum coating. Traditional approaches also do not prevent the loss of functional electrolyte, often producing waste streams that are hazardous to public health.

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Technology Description

The INL-developed process provides a protective aluminum coating by exposing components to a high-temperature aluminum-bromide plating bath. The bromine solution, which can be prepared with lithium, potassium or cesium, is heated and homogenized to a maximum temperature of 350 degrees Celsius. A pulsed technique is used to make the coatings more adherent and robust. Post-coating, the samples are annealed at temperatures ranging up to 500 degrees Celsius.

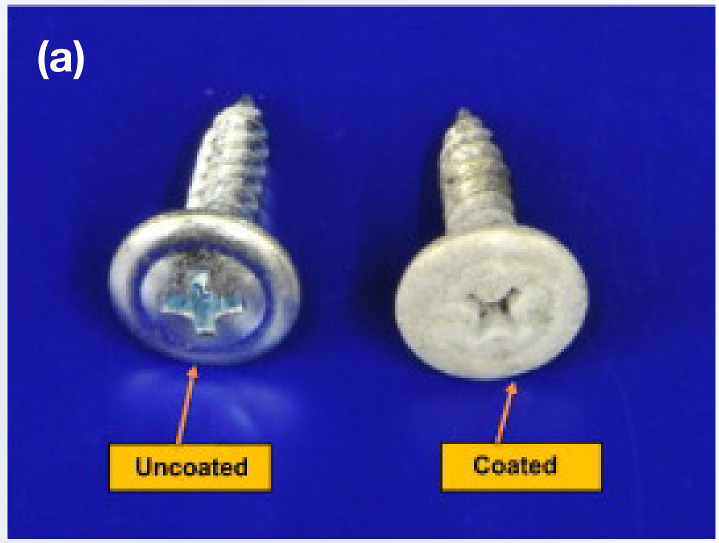
After repeated tests, samples exhibited formation of a much stronger surface layer. Moreover, the composition of the surface layer was not pure aluminum, but also incorporated the innermost substrate (e.g., stainless steel) and the intermediate substrate-aluminum composite.

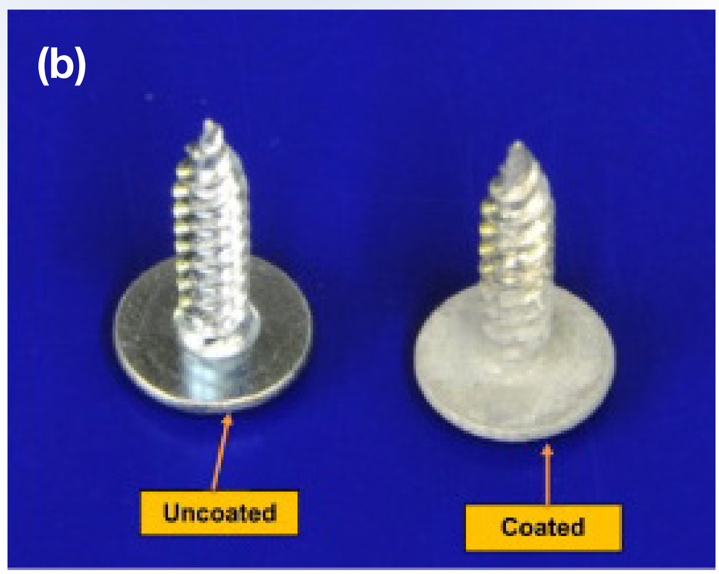
Technological Benefits

- Generic process can be applied to a wide range of metals and alloys
- Superior corrosion protection ability and mitigation characteristics
- Greater strength due to high-temperature bonding between surface and substrate materials
- Process requires no new equipment or major adjustments to existing infrastructure.

Potential Applications

Structural or functional materials in marine or wet environments; coating neodymium iron boron magnets to extend life span and functionality; aerospace, automotive, civil engineering; improved life span of nuclear reactor pressure vessels.





Screws before they are plated using bromide salts and after the process.

For more information

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Related Publication
Prabhat K. Tripathy, Laura A. Wurth, Eric J. Dufek, Toni Y. Gutknecht, Natalie J. Gese, Paula A. Hahn, Steven M. Frank, Guy L. Fredrickson, J. Stephen Herring. Aluminum electroplating on steel from a fused bromide electrolyte. - Surface & Coatings Technology, 2014, v. 258, p. 652-663

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