New self-healing coating for aluminum developed to replace cancer-causing product

October 22 2012

A University of Nevada, Reno research team has developed a new environmentally-friendly self-healing coating for aluminum that can be used for defense and aerospace applications. Graduate students David Rodriquez and Dev Chidambaram, principal investigator, are studying an aluminum sample after the scratch test using a Raman microspectroscope to show the presence of molybdate in the scratched region. Credit: Photo by Mike Wolterbeek, University of Nevada, Reno.

A research team at the University of Nevada, Reno has developed a new environmentally-friendly coating for aluminum to replace the carcinogenic chromate coatings used in aerospace applications. The chromate conversion coatings have been used for more than 50 years to protect aluminum from corrosion.

The team presented their research last week at the international Pacific

Rim Meeting on Electrochemical and Solid-State Science in Hawaii.

"It was well received at the conference," Dev Chidambaram, lead scientist and assistant professor of materials science and engineering at the University of Nevada, said. "There is no question that this will be able to replace the chromate-based coating. Even though the coating formulation is yet to be optimized, the coating has shown exceptional performance."

Attempts to replace chromate coatings with non-toxic coatings have been underway since the 1980s. The awareness on effects of chromates was brought to the forefront in 1993 by the real-life incident involving Erin Brokovich and depicted in the movie released in 2000 of the same name. Although the use of chromates for consumer and automotive applications has been banned, it is still in use by the defense and aerospace industries under various exemptions.

The carcinogenic coatings were exempted from the ban due to unavailability of suitable replacement combined with the high human and financial cost of failure from corrosion. The search for a suitable replacement has been elusive primarily due to one main characteristic of the coating referred to as "self-healing," the ability of the coating to heal itself after being damaged or scratched.

When scratched, the coating components from nearby sites migrate to the damaged region and re-protect the underlying alloy. A short video of the coating formation is on Chidambaram's website, www.electrochemical.org/ under the heading "Cool Videos."

Chidambaram's formulation performs comparably to the chromate formula in its ability for self-healing, which is important to the defense and aerospace industry. The coating can be applied to all aluminum products. The new formula creates an environmentally-benign molybdate-

based coating that provides corrosion protection to aluminum, used for aircraft and spacecraft. These coatings, when damaged, will re-heal themselves.

The University of Nevada, Reno team developed and tested more than 300 coatings before arriving at this formulation. They used a complimentary suite of advanced surface analytical techniques such as Raman microspectroscopy, Fourier transform infrared spectroscopy, energy dispersive spectroscopy, secondary ion mass spectroscopy and X-ray photoelectron spectroscopy to conclusively prove the presence of molybdate in the scratched region. Further, using electrochemical testing, the team showed the coating re-protected itself via self-healing upon scratch test.

The team includes graduate student David Rodriquez, who conducted the extensive testing on the materials, and undergraduate aerospace engineering major at the University of Colorado, Boulder intern Roshan Misra, who began the project as a high school summer intern from Reno High School. The team is still working to optimize the coating formulation for even better protection.

"This has taken 14 years of work, continuing on work I did at the State University of New York at Stony Brook and the Brookhaven National Laboratory," Chidambaram said.

Provided by University of Nevada, Reno