FACILE DEPOSITION OF LOW CONTACT RESISTANCE NANO-COAT PASSIVATES FOR ELECTRICAL COMPONENTS (PROJECT SUMMARY AND LAYOUT)

1. Objective:

SERDP SEED SON PROJECT, WP2528 SEED, directed the development of technologies for the passivation of corrosion resistant coatings used in Department of Defense electrical system components so that the use of hexavalent chromium can be eliminated. A proof of new concept of laying down an electrically conducting and a passivating nano layer, which is a few atoms in thickness, is generated on the substrate surface. The coatings are robust chemical passivates and can be developed to match or exceed the performance of hexchrome for corrosion passivation. The key features of the nano-coatings are: (1) good adhesion, (2) low cost, (3) complete coverage of the connector surface, (4) protection from atmospheric and galvanic corrosion and (5) do not catalyze electrochemical reactions. The materials used to realize the nano passivation layer are commercially available and can be handled under ambient conditions. The application of the proposed technology is focused but not limited to Low Hydrogen Embrittlement (LHE) Zinc/Nickel (ZnNi) on aluminum.

2. Technical Approach:

The electrically conducting nano passivating layer has been generated by the use of precursors that generate active species using Atomic Layer Deposition (ALD)-inks that can lay down atomic layers of metals under idealized conditions. Averatek's precursor inks are tunable to match rheology of the surface and generate nano or sub-nano layers that are converted into thermodynamically stable nano-composition in situ by wet chemistry methods. These nano/sub-nano layers are (i) electrically conducting and (ii) resists electron transfer process in air and aqueous salt solution and thus are able to provide protection against both atmospheric and galvanic corrosion. The precursor inks are based on environmentally friendly metals such as palladium, copper, silver, etc. The LHE ZnNi on aluminum has been the substrate of interest but other connector alloys and surfaces are also expected to respond similarly. The approach consists of (1) tailoring precursor inks for control of composition of the catalytic layer, (2) using appropriate chemically active species to generate thermodynamically stable nano network of atoms constituting the nano passivating coating. The nano-coatings were tested in salt spray chamber and compared with uncoated substrate.

3. Benefits and implications for future work:

The nano coatings are constituted of friendly metals such as palladium, copper, silver etc. and can be developed to meet the requirements of the Department of Defense to replace the use of hexchrome as a passivate on the electrical connectors. These coatings are not only electrically conducting but also act as corrosion passivates and are resistive to wear unlike the organic coatings which are dielectric and scratchable. The nano coatings are free from hydrogen embrittlement issues. The materials and the process are all implementable under ambient conditions. The basic principle of chemical passivation for generating corrosion passivating compositions while retaining metallic conductivity is the key attribute of the proposed technology.

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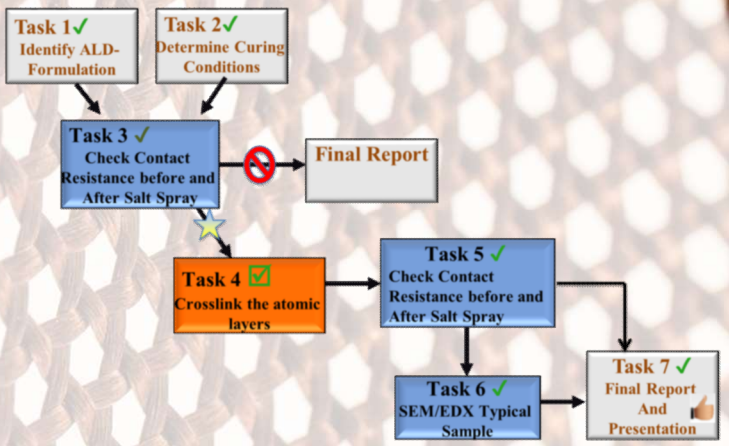

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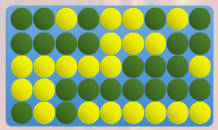
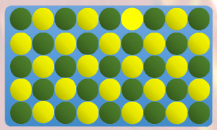
(Next Steps)

ATOMIC LAYER DEPOSITION OF ACTIVE COATINGS



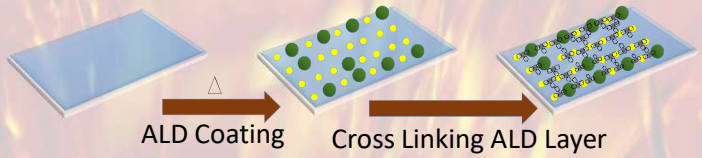
Deposition of Mixed Metal ALD Layer Using Noncompatible Precursors



Deposition of Mixed Metal ALD Layer Using Compatible Precursors

- Metal 1
- Metal 2

PROCESS STEPS



Metal Substrate | **ALD Nano-Alloy Layer** | **Electrically Conducting Cross Linked Passivating Layer**

- **ALD Metal 1**
- **ALD Metal 2**
- **Cross Linker**

IMPORTANT ATTRIBUTES OF CORROSION PASSIVATING ELECTRICALLY CONDUCTING NANO LAYER:

- Low cost precursors based on commercial off the shelf materials
- ALD precursors are stable in ambient air
- No toxic materials used
- Passivating coatings are electrically conducting and have extraordinary chemical and corrosion resistance
- Cross section SEMs indicate Nano thin coating of the electrically conducting passivating layer
- EDX indicates Nano coating has metals in unusual oxidation state
- Can be formulated to be compatible with several metals and alloys

Averatek Corporation, a high tech company based in Santa Clara, CA, is a nimble product, services, and technology company that makes surface treatments and metallized electronic material using a patented proprietary additive process.