NANOBYTE

Nanocomposite Coatings for Army Erosion Protection

For The

Defense Logistics Enterprise Services Program (DLESP)

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Problem:

- Sand from desert operations can inflict significant erosion of critical components in vehicles. The resulting negative impact includes increased maintenance costs, prolonged maintenance periods, decreased vehicle performance, and decreased operational capabilities.

Systems of Interest:

- Helicopter Rotor Blades
- Turbine Engine Inlet Guide Vanes
- Ground Vehicle Axles

Coating Solutions:

- Elastomeric Nanocomposite Coating (e.g. Aerocoat K™)
- Nanostructured Ceramic Coating (e.g. Alumina-Titania)

Recommendations:

- Nanocomposite coatings offer opportunities for reduced maintenance costs and increased combat readiness associated with erosion.
- The performance of these coating systems should be independently evaluated by Army or Army-contracted engineers unaffiliated with the service/product providers to insure compatibility with system-specific applications.
- In addition to the two nanocomposite coatings discussed herein, Army engineers should consider other nanostructured coatings (e.g. tungsten carbide cobalt, titanium dioxide) for possible superior matches to application needs.

Aerocoat K™

Description: Elastomeric nanocomposite coating consisting of silica nanoparticles dispersed in a polymer matrix.
Application Suitability: Helicopter Rotor Blades, Turbine Engine Inlet Guide Vanes
Material Manufacturer: Analytical Services & Materials, Inc.
Vendor: Vertical Logic, LLC

Manufacturing:
- Commercial spraying; No special equipment necessary.
- Can be applied in paste form for field repairs
- 24hr ambient curing

Material Properties:
- Flexible, energy absorbing due to polymer matrix, but tough due to silica nanoparticles
- Excellent environmental resistance (corrosion, ice)
- Suitable temperature range = -70 to 400 ºF
- Solid particle erosion protection (low/high angle): 4.2 / 3.4 µg/g
  - 6x vs. Polyurethane Tape
  - 13x / 8x vs. Aluminum
  - 20x / 13x vs. Ti6Al4V
  - 21x / 17x vs. Steel
  - 30x / 23x vs. Nickel
- Cavitation protection = 1 mg/hour @ 500W, 20 kHz
  - 2x vs. Polyurethane Tape
  - 3x vs. Stainless Steel
  - 10x vs. Nickel
  - 39x vs. Aluminum
- Adhesion strength = 20-24 psi vs. 3 psi for Polyurethane Tape

Cost: $18/sq. ft (without application costs, assuming 0.01” thick)
Notes:
- No “Corona Effect” during night operations
- References Available [1,2,3]

Nanostructured Ceramic Coating

Description:	Nanostructured alumina-titania (87:13) ceramic coating; Modified feedstock includes 6-8wt% cerium oxide and 8-10wt% zinc oxide.
Application Suitability:	Turbine Engine Inlet Guide Vanes, Ground Vehicle Axles
Feedstock Manufacturer:	Inframat Advanced Materials, LLC
Thermal Spray Services:	A&A Company, Inc.; F.W. Gartner Thermal Spraying, Ltd.; Raymor Industries
R&D Consultant:	Perpetual Technologies, Inc.

Manufacturing: Commercial thermal spray technology

Material Properties:

- Unmodified nanocoating MIL-STD-1687 certified ("Thermal Spray Coatings for Shipboard Machinery")
- Nano adhesion strength = 2x conventional
- Unmodified Nano bond strength ˜ 10,000 psi
- Unmodified Nano hardness = HRC 54 (˜ conventional)
- Bend test:
  - Conventional = Failure
  - Unmodified Nano = Partial
  - Modified Nano = Pass
- Cup test:
  - Conventional = Significant cracking/spallation
  - Nano (Both) = Minimum cracking/spallation
- Abrasion Wear Resistance (normalized):
  - Conventional = 1
  - Unmodified Nano = 2
  - Modified Nano = 4
- Slurry emersion testing = 2x improvement for Nano

Cost: $45/lb. for large quantities (feedstock only)

Notes:

- Perpetual Technologies has a proprietary thermal spray process that claims to provide as much as 2x further improvement in properties
- References Available [4,5,6,7,8,9,10,11,12]

References

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