



2004 MDA Technology Applications Report REPRINT



Coatings

Inovati
Santa Barbara, California

Have you ever had a deep scratch down the side of your car that you waited too long to fix? The exposed metal reacts with rain and oxygen in the air to form a corrosion product—commonly called rust. If rain can cause something to rust and deteriorate, imagine the capabilities of salt water. That is what the U.S. Navy deals with on a daily basis.

The Naval Surface Warfare Center (NSWC) Carderock Division is responsible for all technical aspects of improving performance of ships, submarines, military watercraft, and unmanned vehicles for the Navy. The NSWC recently installed a Kinetic Metallization (KM) coating development system developed by Inovati. KM is a solid-state deposition process that creates and applies corrosion-resistant coatings. Conventional thermal spray coatings tend to be ineffective in seawater because they are excessively porous, which allows seawater to seep through. KM allows the deposition of fully dense coatings, minimizing porosity and in turn reducing corrosion. Thermal spray also contains scattered concentrations of oxides, which create pathways for the corrosion process. KM coatings have oxides evenly distributed throughout, which creates a more uniform microstructure that blocks the corrosive properties of sea water.

Kinetic Metallization

Description: Solid-state deposition process that applies superior wear- and corrosion-resistant coatings

Price Range: \$160,000

Customer Base: U.S. Navy, U.S. Air Force, The Boeing Company, Lockheed Martin, Hendry Telephone Products, NASA, Royal Australian Navy, Pratt & Whitney, Honeywell Inc., Goodrich Corporation

Benefits: 1. Creates stronger, more effective coatings than thermal spraying while remaining cost-effective, 2. Is more environmentally friendly than electroplating, 3. Preserves the original microstructure of the material using a low-temperature process

Additional Applications

Automotive: Provides light-weight structures, wear-resistant surfaces, bearings, fuel cells, and electrical sensor components

Medical: Provides porous coatings on joint replacement implants to promote long-term biological fixation and bio-compatible coatings on other implanted medical devices

Materials: Provides new materials for smart structures (embedded sensors, shape altering, nano-particle consolidation) and amorphous metal consolidation

Aerospace: Provides gas turbine engine airfoil repair and coating, hard chrome replacement, cadmium replacement, rocket nozzle coatings, and free-form fabrication of attitude thrusters

Kinetic Metallization

KM is a solid-state process that can blend metals and alloys, which are normally unmixable using conventional processes. Inovati developed the KM process to produce metal coatings for wear resistance, corrosion protection, and metal joining. The process uses an inert gas as a carrier to spray metallic powders such as aluminum, titanium, niobium, molybdenum, or



▲ *Inovati's KM coating development system, which is smaller than an office desk and does not require hearing protection, is used for development of coatings by aeronautics, space, defense, and industrial customers.*

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Company Vision

“KM will be the leading surface engineering process for premium quality coatings and spray-formed goods within five years. Specific market-penetration goals include replacement of 25 percent of the preeminent thermal spray (HVOF, LPPS, D-Gun) coatings market, 15 percent of the functional electroplating market, and will enable the production of new materials not currently available.”

*Howard Gable,
President*

copper onto a metal substrate. Similar to thermal spray coating, but achieved at temperatures far below the melting point of the powders, the velocity of a carrier gas provides the energy needed to make the metal powder bond to the substrate. Inovati's KM process makes stronger, more durable coatings by balancing the pressure and velocity of the carrier gas, which keeps the particles soft without heating them to the point where they melt, oxidize, or otherwise interact. If they did interact, the particles would waste their reactivity before hitting the substrate, and could only stick to it via a weak mechanical bond. The precisely controlled KM process delays the chemical reaction until impact with the surface, at which time the particles deform and increase their surface area about four-fold. By doing so, they expose fresh metal surfaces that reacts (adhesively) with the substrate and (cohesively) with each other, which produces a strong metallurgical bond. KM allows nanoparticles to be consolidated while maintaining their characteristics—ductility, strength, magnetic permeability—for which they were engineered. The process is also environmentally friendly while maintaining the same or better properties as those applied with conventional coating techniques.

MDA Application

Years Funded: 1997-1999

Originally, MDA funded Inovati to develop an improved, low-cost, solid-state coating process to provide wear resistance, corrosion protection, and metal joining for lightweight missile structures. Recently, MDA has become interested in using the company's KM process for energetic structural materials and production of thruster nozzles. Besides coatings, the system can be used for spray-forming applications in structural elements of interceptor missiles, which will immediately start burning at very high temperatures upon impact with the target.

Company Profile

Business Overview: Inovati uses its Kinetic Metallization technology to provide coating services. The company also manufactures and sells the system plus related equipment and consumables.

Founded: 1989

Employees: 6

2003 Revenues: \$2 million

Facility: Inovati is housed in a 5,000-square-foot facility with full manufacturing capabilities.

Partners: None

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