



INDUSTRIAL TECHNOLOGIES PROGRAM

Structurally Integrated Coatings for Wear and Corrosion Resistance

Emerging Deposition Processes Will Enable Fabrication of Low-Cost, Metallurgically Bonded Coatings on Steels with Improved Performance

Materials degradation by simultaneous wear and corrosion is responsible for failure and life reduction of many components in track undercarriages, ground-engaging tools, piston rings and liners, engine valves, pumps, and other mobile systems. Research has shown that engineered surfaces, such as thin-film coatings applied by physical and chemical vapor deposition on corrosion-resistant sub-layers, can address combined wear and corrosion issues in applications that have lacked solutions for decades. However, some of the major issues that remain include the relatively high cost and the inability of thin films to provide enough wear resistance for heavy, abrasive wear applications. Processes that form metallurgically bonded coatings of 1-mm

thickness or more have been shown to be lower in cost and substantially more resistant to wear than baseline heat-treated steel materials. There is a need to develop improved, yet affordable surfacing materials and processes for wear and corrosion resistance in both sliding and abrasive wear applications. The magnitude of performance improvement sought is four to eight times that for carburized steels, while affordability needs to be assessed against competing hard-surfacing or coating techniques and balanced with overall coating performance. Deposition processes including arc lamp fusing of thermal spray coatings, laser-aided thermal spraying, hybrid laser-arc cladding, and plasma transferred arc (PTA) are candidate processes that will be evaluated in this project.



Low-cost wear-resistant coatings will replace carburized components in various applications



Benefits for Our Nation and Our Industry

Improved and cost-effective coating technologies will result in decreased use of carburized parts, wear- and erosion-resistant coatings, coatings free of cracking, and coatings with favorable residual stresses. Energy benefits will be obtained through reduced carburization treatments and potential use of lightweight parts in heavy equipment.

Applications in Our Nation's Industry

Materials with wear resistance four to eight times that of carburized steels will find applications in the aluminum, forest products, mining, and steel industries.

Project Description

The goal of the project is to develop two or more materials systems that provide a four- to eightfold increase in wear resistance over current carburized steels. In addition, two processes that are economically attractive will be developed from four emerging technologies for the deposition of these coatings.

Barriers

Major barriers to be overcome include:

- The need to balance cost and materials-performance factors in the development of coatings;
- The tendency for coatings to crack after processing due to the use of hard materials and the presence of residual stresses; and
- Lack of thermodynamic and other data required for microstructural modeling.

Pathways

The objectives of this project will be achieved through the following concepts: (1) alloy composition development and feedstock evaluation for each of the four coating processes; (2) coating deposition and individual process optimization; (3) screening of coatings using corrosion, wear, and fracture toughness testing; (4) laboratory component testing using simulated conditions; (5) materials property evaluation for input to computational models; (6) microstructural modeling that incorporates thermo-fluid process models; and (7) process evaluation to down-select two processes that will be commercially viable.

Progress and Milestones

- Conduct economic and industrial feasibility analyses of coating processes and select candidate processes and materials (Complete)
- Estimate viability of feedstock materials and associated processing required prior to coating deposition (Complete)
- Produce initial coatings using down-selected coating process, using up to four material systems per process (Complete)
- Determine material and coating properties required for microstructural modeling (Complete)
- Complete coating microstructural evolution modeling (Complete)
- Complete mechanical/ toughness screening of promising coating systems

Commercialization

Field tests of the coating systems are ongoing in West Virginia, North Carolina, and Arizona and commercialization of the materials will proceed based on those results.

Caterpillar is a major manufacturer of equipment for various industries. New materials developed as part of the project will be commercialized through implementation in equipment manufactured by Caterpillar. Various manufacturing processes are available for licensing from their owners and will facilitate the commercialization of the materials and processes developed as part of this project.

Project Partners

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A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.



U.S. Department of Energy
Energy Efficiency
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Bringing you a prosperous future where energy
is clean, abundant, reliable, and affordable

Ending FY07
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