Advanced Composite Coatings for Industries of the Future

Benefits

The benefits derived from the coatings described in this project include

- Energy savings anticipated by the use of corrosion resistant coatings and
- Savings resulting from decreased fuel needs.

Applications

IOF industries include

- **Chemical and Petrochemical:** Hydrocrackers for the petrochemical Industry, chemical reaction vessels for the chemical industry, heat-recovery systems for hydrocrackers and chemical reactors.
- **Heat Treating and Steel:** Hoods for steel making furnaces and materials for the heat- treating industry.

Other industries include

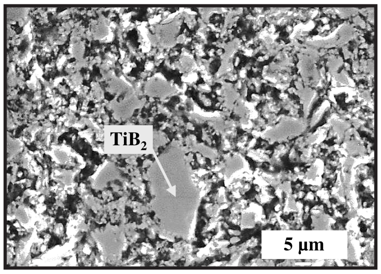
Industrial power generation.

Application of ceramic coatings derived from preceramic precursor polymers will provide an economical solution to high-temperature corrosion

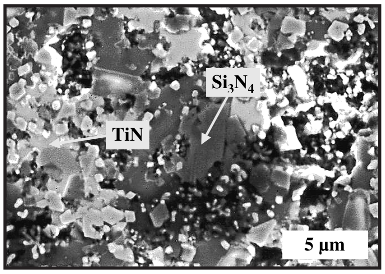
Corrosion is an issue that challenges all industries. Although corrosion-resistant coatings are currently used, enhanced performance requires new materials and methods. This project will focus on two low-cost methods for obtaining advanced composite coatings with improved corrosion resistance for use in industrial applications: pyrolysis of precursors and in situ displacement reaction synthesis.

Corrosion-resistant coatings can reduce manufacturing costs by extending component lifetimes and by allowing the substitution of more economical substrates. In addition, corrosion-resistant coatings can be used to improve process efficiencies and hence lead to energy savings and reductions of emissions. Furthermore, low-temperature routes to ceramic coatings can result in additional energy savings, cost savings, and emissions reductions. Composite coatings containing several functional phases can also provide an effective means for improving performance because compositions and microstructures can be tailored to address critical problems; however, low-cost, relatively simple processing routes are required.

Polymer precursors can be applied by using simple processes, such as spin coating. Shown here is a laboratory-scale spin coater.



Polymer precursor coating using TiB_2 reactive filler materials. Coating is dense with micron-scale porosity.



Polymer precursor coating using $TiSi_2$ reactive filler materials. Coating is dense with micron-scale porosity.

Project Description

Goal: The goal of the project is to develop low-cost, high-temperature corrosion-resistant coatings with superior mechanical properties for industrial applications.

Issues: The proposed project will develop low-cost ceramic coatings for prevention of high-temperature corrosion of metals and ceramics in the chemical industry and industrial power-generation area. These types of coatings are targeted at providing high-temperature (700–1000°C) protection from corrosion due to oxidation, carburization, coking, and metal dusting. This project will require development of methods for producing advanced composite coatings that can easily be tailored for specific applications, yet be flexible enough for use in a variety of applications.

Approach: Two methods will be used to fabricate high-temperature corrosion-resistant ceramic coatings: pyrolysis of preceramic precursors and in situ displacement reactions. Both routes require a thorough understanding of the materials development during coating fabrication and the properties of the material that control the coating behavior. In addition to pursuing these two coating techniques, composite coatings will also be developed as a means to further improve coating performance. Composite coatings will consist of preceramic polymer-derived or in situ displacement reaction material combined with additional constituents that can improve corrosion resistance, mechanical properties, and thermal properties. Tasks include
– Development of corrosion resistant compositions,
– Coating adhesion, and
– Characterization and optimization for service environments.

Potential payoff: If these coatings are successfully developed and implemented significant energy savings can be anticipated.

Progress and Milestones

- Fabrication of specimens for corrosion-resistance testing.
- Corrosion-resistance testing.
- Materials selection.
- Coating media preparation.
- Coating analysis and optimization.
- Coating lifecycle analysis.
- Laboratory exposure testing.
- Component coating.
- Field testing.

Primary

Pacific Northwest National Laboratory
Richland, WA

Project partners

Alon Surface Technologies
Leechburg, PA

Air Products and Chemicals, Inc.
Allentown, PA

Solar Turbines
Dan Diego, CA

Starfire Systems, Inc.
Watervliet, NY

The University of Washington
Seattle, WA

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January 2002