Low-Friction Hard Coatings

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Overview

Timeline

- Start: 10/01/2006
- Finish: 09/30/2012
- %75 Complete

Budget

- Total project funding
  - DOE - $1,000K
- Funding received in FY09 - $125K
- Funding received in FY10 - $200K

Barriers

- Barriers addressed:
  - Durability
  - Performance
  - Manufacturability
- Target:
  - Develop hard and low-friction materials technology needed for achieving superior efficiency and durability in automotive and heavy vehicle propulsion systems

Partners

- Galleon International – Technology Maturation
- Hauzer Techno Coating – Coating process development and scale-up
- Several Engine OEMs, Part Suppliers, Racing Teams, and Car Manufacturers
- Lead: Argonne National Laboratory

Objectives

- **Design, develop, and implement low-friction and superhard coatings to increase durability, fuel economy, and environmental compatibility of engine systems.**
- **Demonstrate large-scale manufacturability of such coatings at reasonable cost.**
- **Characterize and verify their performance through bench-top and fired engine studies.**
- **Transfer optimized technology to industry.**

Milestones or Go/No-Go Decisions

- **FY09:**
  - Go/No-Go Decision: Demonstrate feasibility of larger scale deposition. Verify performance by field testing in fired engines.
  - Go/No-Go Decision: Complete scale-up and initial field studies. Demonstrate larger-scale production and cost competitiveness.
- **FY10:**
  - Go/No-Go Decision: Complete remaining field and performance studies, demonstrate full-scale processing of large numbers of tappets and piston pins (Passenger car engine tappets are selected as a target product in FY10 and motored engine tests represent industry accepted field tests).

Approach

- **Optimize deposition parameters that are most effective in physical, mechanical, and tribological properties of superhard and low friction coatings: MoN-Cu and near-frictionless diamondlike carbon.**
  - **Confirm superior bonding and surface smoothness**
  - **Confirm super-hardness and -low friction**
  - **Confirm extreme resistance to wear and scuffing under prototypical conditions**
- **Demonstrate large-scale production and cost competitiveness.**
- **Demonstrate durability and performance in engine applications.**

Technical Accomplishments/Progress/Results

- Inconsistencies in coating composition, microstructure and properties (e.g., hardness, thickness, copper distribution within coatings) during production-scale depositions in a Hauzer system have been addressed.
  - This involves not only using production scale unit but also production scale loads during deposition.
- Verification of coatings' superior mechanical and tribological properties on tappets by bench-top studies at and above room temperatures (50-80-120°C).

Technical Accomplishments/Progress/Results

- **Demonstrated Technology has won an R&D-100 Award in 2009.**

- **Technology Transfer**
  - Galleon International is finalizing licensing talks with Argonne to commercialize the technology for use in all kinds of engine parts and components
  - There are several engine companies, part suppliers, racing teams, and car manufacturers lined-up for using the coating in their engines
  - As part of technology transfer, Argonne will receive a medium-scale fully-equipped deposition system from Hauzer Technocoating.

Future Work

- Validate optimized coating durability and performance under fired engine conditions (FY2010, 2011).
- Initiate piston ring product specific bench top and field studies in fired engines (FY2011 and 2012).
- Initiate bench top tribology tests in order to decrease the production cost even further by reducing coating thickness from 2 μm to 1 μm (FY2011).
- Current coatings require post polishing (it is a common practice for other component coatings as well), initiate surface analytical studies to investigate top surface layer to find scientific reasons for this necessity in order to eliminate this post process in the future (FY2011).

Summary

- Successfully demonstrated the production of superhard and low friction coatings on a large number of actual engine parts using lab- and –commercial-scale deposition systems with production scale loads.
- Verified the superior tribological properties of coatings in motored engine tests on passenger car tappets.
- Technology transfer and commercialization efforts are in the final stages.