Super Hard Coating Systems

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U.S. Department of Energy

THE UNIVERSITY OF CHICAGO

Office of Science U.S. DEPARTMENT OF ENERGY

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Overview

Timeline

- Start: 10/01/2006
- Finish: 09/30/2010
- %75 Complete

Budget

- Total project funding
  - DOE - $440K
- Funding received in FY08 - $150K
- Funding received in FY09 - $140K

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
- 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.**
- **Characterize and verify their performance through bench-top and engine studies.**

Milestones or Go/No-Go Decisions

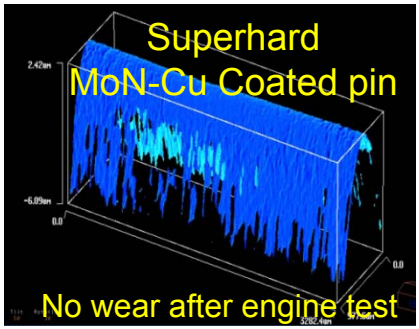
- **FY08:**
  - Go/No-Go Decision: Completion of bench-top testing and component level studies
- **FY09:**
  - Go/No-Go Decision: Demonstrate feasibility of larger scale deposition. Verify performance by field testing in fired engines.
  - Go/No-Go Decision: Complete scale-up and field studies. Demonstrate cost competitiveness.

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
- Demonstrate large-scale production and cost competitiveness.
- Demonstrate durability and performance in engine applications.

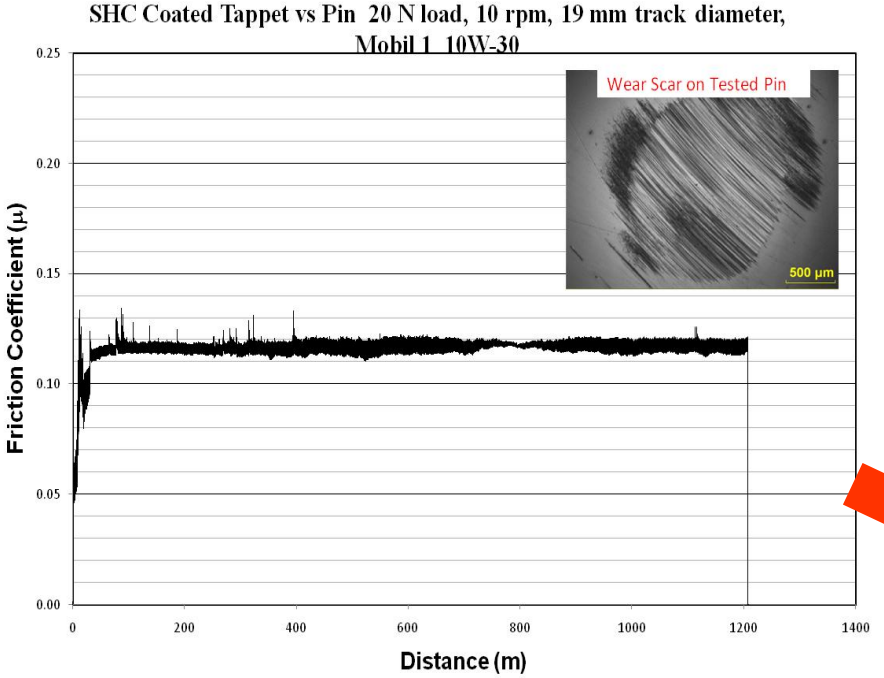
Technical Accomplishments/Progress/Results

- **Deposition of optimized coatings on actual engine components with strong bonding and surface smoothness in a commercial-scale deposition system at Hauzer Techno Coating Company.**



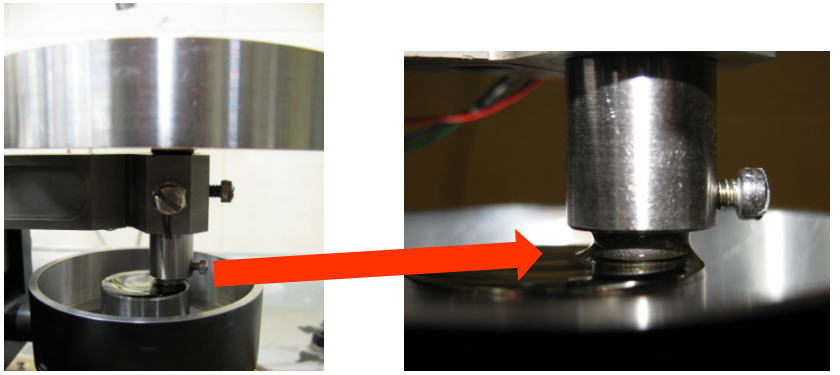
- **Verification of their superior mechanical and tribological properties by bench-top studies.**
- **Completion of initial screening tests by engine company partners.**
  - Compared to 2008 activities, in 2009 most of our attention has been shifted to scale-up and field testing of optimized coatings and validation of their performance and durability in actual engines.

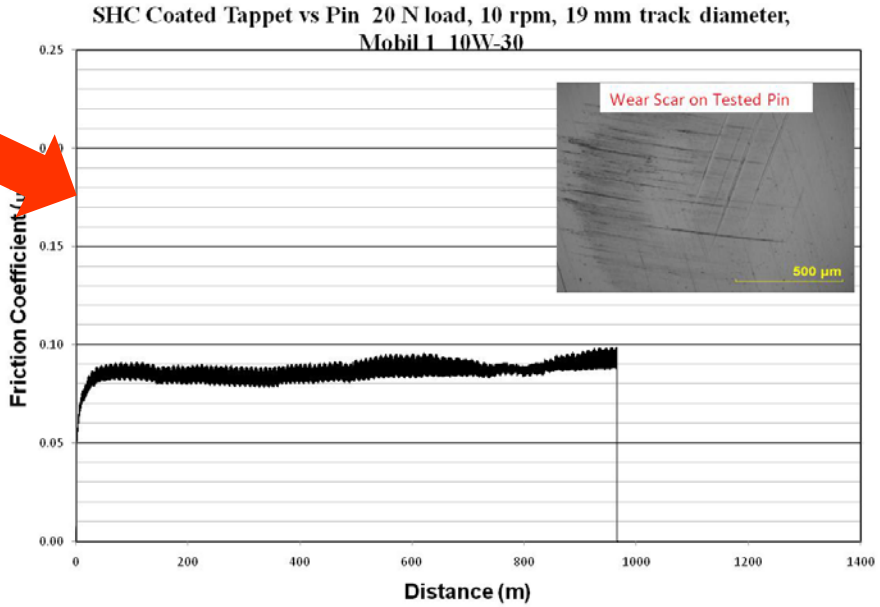
Technical Accomplishments/Progress/Results



Pin on Disc Test on Initially SHC Coated Tappet (Year 2008)

There is a significant reduction in both the **friction** and **wear** of coated **tappets** through deposition process optimization over the last year.





Pin on Disc Test on Recently SHC Coated Tappet (Year 2009)

Technical Accomplishments/Progress/Results

- **Scale-up**
  - Working with Galleon International and Hauzer Techno Coating (one of the largest industrial coating companies), in FY2009, we concentrated on scale-up and production of these coatings on tappets, piston pins, piston rings, and fuel injectors for testing by many companies.
- **Technology Transfer**
  - Galleon International initiated licensing talks with Argonne to commercialize the technology


Superhard MoN-Cu Coated Tappets

Future Work

- Validate **manufacturability** of optimized coatings in the **commercial-scale deposition systems** of our coating partner (Hauzer) (FY2009).
- Validate their **durability and performance under actual engine conditions** (motored/fired) (FY2009).
- Concentrate on **technology transfer and commercialization** (FY2010)
  - Increase collaboration with industrial partners
  - Demonstrate cost-competitiveness and benefits
  - Finalize licensing talks and commercialize the coatings.

Summary

- Successfully demonstrated the production of superhard and low friction coatings using lab- and – commercial-scale deposition systems.
  - By virtue of their superhardness, these coatings prevented wear and scuffing failures in piston pins and tappets.
  - Because of their low-friction character, they can increase fuel economy of future engines.
  - Less fuel consumption means less green-house and other hazardous gasses released to environment.
  - These coatings are applicable to numerous engine components (can also be used in manufacturing for machining, metalforming, etc.)
- Technology transfer and commercialization efforts are currently underway and will further intensify in 2010.