INVENTIONS & INNOVATION

Project Fact Sheet

TOUGH-COATED HARD POWDERS

NEW CLASS OF TOOL AND DIE COMPONENTS EXHIBITS SUPERIOR COMBINED HARDNESS PROPERTIES RESULTING IN LONGER WEAR

Benefits

- Could save approximately $6 million per year in the U.S. mining industry through reduced energy consumption

For tool manufacturers:

- Dramatically higher coating efficiencies in powder form eliminate the need for expensive chemical vapor deposition (CVD) tool coatings and milling time, reducing costs while improving tool performance and profitability
- Softer binder-coated powder coatings extend life of press tooling
- Higher-performance tools lead to premium prices and increased margins

For tool end users:

- Significantly extends first life of tools and adds tool recycling through economical regrinding and reusing of tools
- Improves retention of tool surface shape at a cost comparable with or below conventional tools
- Real productivity, quality, and inventory gains through fewer tool changeouts
- Offers positive environmental and energy-use benefits

Applications

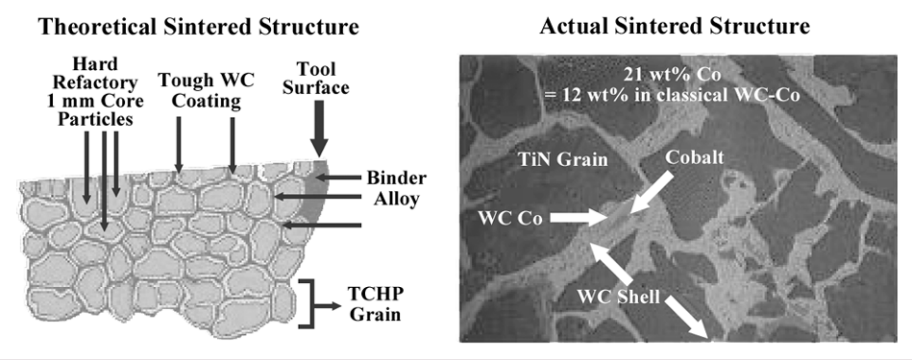
TCHPs can replace tungsten carbide and cobalt mixes in the production of most types of hard products. Key applications include metal forming/cutting tooling, wire drawing dies, steel-mill rolls and shears, and mechanical parts requiring special properties.

The more resistant a tool or die is to shock, chipping, fracture, heat breakdown, fatigue, and wear, the longer it will last. Better tools allow higher material-removal rates and longer retention of the tool surface shape. Desirable mechanical properties of tool and die components include hardness, high elasticity, fracture toughness, low chemical interaction with the work piece, and low coefficient of friction to reduce sliding and heat build-up.

Traditionally, wear resistance in tooling increases at the expense of strength. Today, the best tools reveal compromises among desired mechanical properties. Over the years, coatings, new materials, and mixed nanoscale powders have all contributed to increased performance, but have not yet yielded the desired combination of toughness and strength needed to meet the challenges of current materials and conditions.

Initial tests involving EnDurAloy's line of Tough-Coated Hard Powders (TCHP) indicate that this new class of tool material will increase wear life in a wide range of finished products. TCHP "composaloys" allow new combined levels of fracture toughness and hardness; resistance to abrasion, friction, wear, and corrosion; thermal conductivity; and impact resistance throughout the entire tool material. This innovation will likely extend uncoated tool life 10 to 30 times and coated tool life approximately four to seven times. In addition, the tool material can be reground and recycled an additional one to five times before disposal.

TOUGH-COATED HARD POWDERS



Tools made with Tough-Coated Hard Powders do not require an external coating because hard and tough phases are already dispersed throughout the tool, resulting in a continuously renewed wear surface within a tough substrate.

In thermal spray applications, unoptimized TCHP coatings can aceive wear improvements of 5 times previous coatings. After optimization, wear improvements of 10-15 times are expected.

Project Description

Goal: The project goal is to improve coating and consolidation methods for the Tough-Coated Hard Powders.

The TCHP concept is a unique cellular structure of engineered submicron particles whose interconnected tough tungsten carbide or tool steel load-bearing shells contain a superhard, wear-resistant refractory alloy core. This "designer particle" combines normally conflicting material properties and integrates them so they operate simultaneously. TCHPs are coated with tungsten carbide and a binder and substituted for traditional tungsten carbide/cobalt powder mixes. The powder is then consolidated using one of several liquid-phase or solid-state methods. The result is a structure with superior toughness on the outside and wear-resistance on the inside with load-bearing strength borne by and through the bonded shell ligament structure.

Blending different core powders with the same coatings, thousands of new TCHP composaloys with new combinations of properties are now possible. This novel family of materials frees materials engineers from the limitations of equilibrium phenomena inherent in conventional alloys, where constituent alloy properties are averaged or adulterated following the rule of mixtures.

EnDurAloy Corporation is developing this new technology with the help of a grant funded by the Inventions and Innovation Program through the U.S. Department of Energy's Office of Industrial Technologies.

Progress and Milestones

- EnDurAloy Corporation is developing a line of TCHPs capable of addressing high-volume critical applications. The TCHP technology has attracted the interest and support of several key industry players, each positioned to lead the deployment of this new technology throughout their respective industries.
- The technical and economic feasibility of Tough-Coated Hard Powders has been confirmed, and current efforts are being directed toward improving the coating and consolidation processes.
- The TCHP technology is covered under International Patent Application No. PCT/US98/09767.

Economics and Commercial Potential

TCHPs are intended to replace traditional tungsten carbide/cobalt mixes in the production of most types of finished products. The world market for finished products is estimated to exceed $10 billion, of which over 40% is based on tungsten/cobalt carbides. This would create an immediate market potential for the TCHPs of over $4 billion.

Premium performance and highly competitive cost will be the key factors of success for the TCHP technology. Tool producers should expect to realize 30% to 40% operating cost savings due to dispersing the powders through the material, as opposed to coating technologies currently available. The already-treated TCHPs also eliminate most other mixing operations in conventional processes, further reducing production costs. These designer powders allow engineers to combine many specialty-tool application and customer challenges into fewer variants, reducing part numbers and inventory costs while facilitating tool selection and sales effort.

It is estimated that TCHPs could generate $13 billion annually in worldwide energy savings, after market conversion. End users will see an approximate 10% to 30% improvement in productivity and quality costs, not including the 10% to 15% cost benefit of reduced chip recycling or eliminated lubricant use.

The Inventions and Innovation Program works with inventors of energy-related technologies to establish technical performance and to conduct early development. Ideas that have significant energy-savings impact and market potential are chosen for financial assistance through a competitive solicitation process. Technical guidance and commercialization support are also extended to successful applicants.

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