Benefits of EternAloy™ (TCHP) To Tool Producers

Significant commercial advantages of the TCHP invention will generate demand for TCHPs with tool producers

A. Tool Manufacturer TCHP Benefits

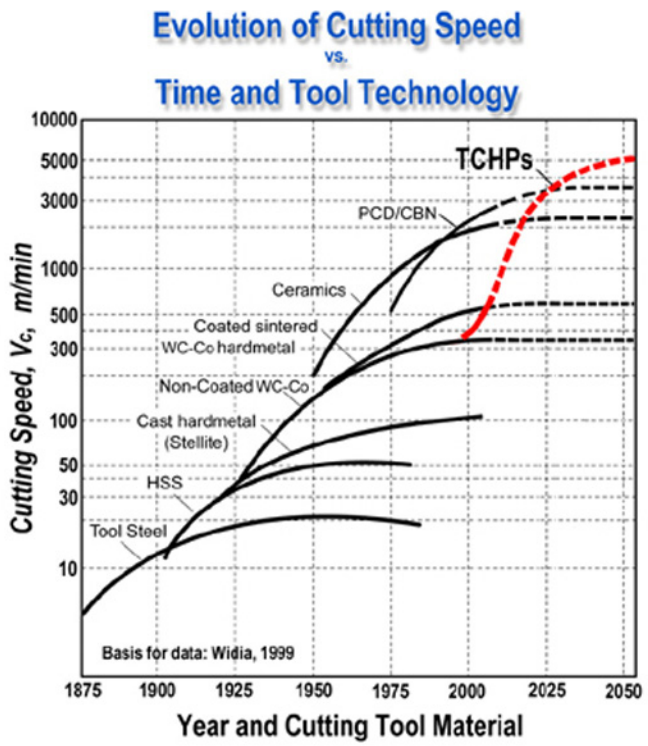
The "designer powder" concept adds value at the powder stage, where it is vastly more efficient—and effective—than adding value (such as thin coatings) to already-sintered tools

Accelerated TCHP Product Development

Although TCHP is very much like conventional WC-Co hardmetals in most chemical and metallurgical regards, it is significantly different in others, particularly mechanical and wear properties. Applying and leveraging what has been globally learned about carbides for 70 years, and thanks to the familiarity developers already have with the raw materials in EternAloy™, TCHP development will advance *much* more quickly than with other new materials. For example, the chemical bonding of of TiN onto WC substrates by conventional CVD coating is identical when CVD coating WC onto TiN core TCHP particles. However, the mechanical bonding from coating TCHP core particles is much stronger than from coating smooth WC substrates.

Coating

Coating TCHP powders is thousands of times more efficient than coating the outsides of tools. This is because (1) CVD is a surface-related process and the surface area of the powder contained in a typical



indexable insert is 4000-5000 times that of the external surface of the finished tool currently coated and (2) coatings on micron TCHP particles are orders of magnitude thinner (and therefore requiring shorter deposition time) than coatings on inserts. Adding value to the EternAloy™ powder eliminates tool-coating operations that take 20-36 hours' residence in

Allomet Corporation
509 Hahntown–Wendel Road
North Huntingdon, PA 15642
www.allomet.net

a CVD furnace to coat up to 15 microns on indexable inserts and average 17-30% of the tool manufacturer's gross cost while improving tool performance tens of times.

Milling

In conventional hardmetals, it takes 20-90 hours of milling time to mix WC and binder powders and wax. TCHP's have the cobalt already deposited atom-by-atom onto the powder, eliminating 97% of this cost, or 2-3% of the gross tool cost. This also results in increasing product structure homogeneity and sintering efficiency, reducing local cobalt concentration gradients that cause grain growth.

Coherent Product Lines, Lean Manufacturing

General purpose, high-performance TCHP tools designed to handle multiple tool challenges will reduce tool grade redundancy and the associated waste in manufacturing (small lot sizes), sales and marketing effort, huge catalogs, inventory, price discounting, and obsolescence. Depending on conditions, the associated financial benefits can easily range from 10 to over 50%.

Cost Reduction via Protection of Mold, PIM, and MIM Tooling[1]

Consolidation of TCHPs of single or multiple core particle variants, whether for tooling or for industrial articles, will involve mixing with organic waxes and binders to aid in their plastification, compaction, and net-shape sintering. For uniform distribution of both the tough (*e.g.,* WC phase) and the metal binder (*e.g.,* Co) in the TCHP structure, all core particle variants are to be coated essentially in the same way, *e.g.,* with WC and Co. The external coating of such a metallic Co binder has typically 20% of the hardness of a WC coating, and 12 to 35% of the hardness of some other uncoated particle choices. This has the important cost-beneficial effect of prolonging the life of this very expensive tooling by exposing it to proportionately less abrasive wear by the soft exterior of TCHP in particulate form. Individual pieces of this tooling such as molds, PIM plastifier screws, dies, and rams can cost hundreds of thousands of dollars per item and, in an industrial operation it would not be unusual to have an idle inventory of such items valued in the tens of millions of dollars.

Material and Labor Productivity

Significant energy, labor, and raw material savings will be added to the above by not producing new carbide tools converted to longer-life TCHP's. In addition, TCHP's use about half the traditional amounts of tungsten and cobalt, often replacing the volume with cheaper but more performant materials such as alumina or cubic boron nitride.

Better Margins

Higher-performance tools and partially commensurate pricing on reduced costs will magnify margins while providing lower tooling costs for customers.

B. Tool Designer TCHP Benefits

The "designer powder" concept allows the engineer to address multiple specialty tool application challenges with fewer TCHP tool variants that will facilitate meeting customer needs while reducing their tool crib inventories and tool selection guesswork. TCHP versatile design features will facilitate rapid development, prototyping, and delivery of specialty products in special, high-margin applications and allow users to have a variety of test samples available quickly. This responsiveness advantage should help grow the business quickly. Some EternAloy™ design parameters are as follows:

- Increasing WC particle coating thickness in higher strength applications, or decreasing it in more critical wear applications.

- Increasing core particle volume % to meet more severe requirements for wear resistance (*e.g.* silicon-containing aluminum alloys), or decreasing it for higher strength applications.
- Selecting core particle materials with characteristics (hardness, coefficient of friction, ...) known to perform better with specific applications (flank wear, crater wear, ...).
- Blending the above thickness, diameter, and core material powder parameters.
- Blending multiple core alloys with needed properties, remembering they all have a common WC (or other) coating material.
- Transitioning gradually from zones or layers rich in harder phases to those with more tungsten carbide (even to 100% WC if necessary) using extruded or injected sections.
- High stresses on *external* tool coatings and other functional laminations commonly result in their delamination and fracture. This is caused by differential thermal expansion rates over large *centimeter-range* interface areas. The stresses will be significantly reduced over *micrometer-range* coating-particle interfaces. This "forgiving" character of thermal expansion differentials at small scale is already well illustrated by the very high thermal expansion rate differences existing without consequence between micron-sized cobalt and tungsten carbide substrate phases.

NOTE

1. PIM, or plastic injection molding; and MIM, or metal injection molding.