“Proper Grade Selection for Cemented Tungsten Carbide Tooling and Wear Part Applications in the Packaging and Converting Industry”

Presented by:
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Introduction

- Tungsten Carbide when used as a material for tooling will reduce **costly downtime** and increase **plant profitability**

- Selecting the proper grade of cemented tungsten carbide is a process and the key to success
Purpose

➢ To provide the information you need to select the grade of cemented tungsten carbide that will deliver the optimum performance for your specific application
CEMENTED TUNGSTEN CARBIDE
Primary Ingredients

- **Main Ingredient**
  
  *Tungsten Carbide Powder – WC*

- **Binder Metals** – Holds the WC powders together
  - Cobalt – most common binder material
    - Range from 3% to 30%
  - Nickel – higher resistance to corrosion, less resistance to wear
    - Range from 6% to 12%
Other Ingredients/Additives

- Titanium/Tantalum/Niobium Carbide
  - Grain growth inhibitors
  - Adds thermal stability
  - Used in inserts for cutting steel

- Vanadium Carbide
  - Grain growth inhibitor

- Chromium Carbide
  - Grain growth inhibitor
  - Increases corrosion resistance
Cemented Tungsten Carbide

A blend of powdered metals and wax that is spray dried to form a flowable powder
Cemented Tungsten Carbide

The powder is pressed into solid green (not sintered) carbide blanks.
Cemented Tungsten Carbide

Parts are sintered in vacuum or pressurized sintering furnaces
Cemented Tungsten Carbide

These green parts shrink to approximately half of the original volume during sintering.

The binder metal hardens upon cooling.
Cemented Tungsten Carbide

The sintered product consists of tungsten carbide grains cemented in place with a metal binder.

The result is a very hard wear resistant product.
Expected Benefits

- When you design for cemented tungsten carbide tooling, you’re expecting extended tool life as a result of

Wear Resistance
Wear Resistance

Diamond
Cermets
Cubic Boron Nitride

Hard/Brittle Cemented Carbide Grades

Shock Resistance/Toughness

Soft/Tough Cemented Carbide Grades
High Speed Steels
Conventional Tool Steels
The Challenge to Grade Selection

Wear Resistance

Shock Resistance/Toughness
SELECTING A GRADE

- Complete Failure Analysis Process
- Identify Properties Required
- Select grade that will provide maximum wear resistance
- “Fine Tune”
- Certification
Failure Analysis Process

- **1\textsuperscript{st} step in grade selection**
  - Actual mode of failure
    - Abrasive wear
    - Corrosion
    - Mechanical failure or breakage

- **Identifies metallurgical and chemical properties**
  - Binder material and content, grain size, hardness, density, TRS, magnetic saturation and coercive force
  - Also, compressive strength, modulus of elasticity, thermal conductivity and coefficients of thermal expansion
Failure Analysis Process

- Quality or Process Control Issues
  - Residual Porosity (A, B or C type)
  - Binder lakes
  - Clusters
  - Eta Phase
  - Cross Grade Contamination
  - Pits
  - Largest Grain Size

- Corrosion and other conditions
The properties of cemented tungsten carbide grades are generally determined by:

- binder content
- grain size
- secondary carbides
Effect of Binder Content

- <4%
- 4% - 10%
- 10% - 16%
- > 16%

Shock Resistance/Toughness vs. Wear Resistance
Effect of Grain Size

- Ultra fine 0.5
- Sub micron 0.8
- Medium 1-2
- Coarse > 3

Wear Resistance

Shock Resistance/Toughness
Potential Microstructural Defects that must be avoided

- A, B, or C type Porosity
- Eta-phase
- Non-uniform grain growth
- Binder Lakes
- Clusters
A Porosity: Pores in the microstructure less than 10 microns in diameter.
Porosity: Pores in the microstructure 10-25 microns in diameter.
**C Porosity:** Not true porosity. Rather, carbon porosity consists of discrete areas of graphite, the result of excess carbon in the microstructure.
**Eta phase**
Binder Lakes
**Pits:** Any void in the microstructure whose longest axis exceeds 25 microns but is less than 100 microns.

**Macrovoids:** Any void in the microstructure whose longest axis exceeds 100 micron
Non-uniform grain growth
WC Clusters
Cross Grade Contamination
Hysteresis Curve

- Retentivity
- Coercivity

Saturation

Magnetizing Force In Opposite Direction

Flux Density

Saturation In Opposite Direction

Magnetizing Force

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The selective dissolution of the binder from the cemented carbide microstructure.

Leaching generally occurs through contact with acidic materials.
Corrosion/Leaching
Corrosion/Leaching
Summary

- Cemented tungsten carbide is a proven material for solving wear problems and extending tool life
- Grades can be tailor made for specific applications
- A process is available to insure proper grade selection
Thank you

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Please remember to turn in your evaluation sheet...