HIGHER TECHNICAL INSTITUTE
MECHANICAL ENGINEERING DEPARTMENT

DIPLOMA PROJECT

IMPROVEMENT OF THE WEAR RESISTANCE OF METAL SURFACES

by
PATROKLOS KYRIAKINOS
Model

JUNE 1997

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IMPROVEMENT OF THE WEAR RESISTANCE OF METAL SURFACES

PROJECT NUMBER: M/801

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SUPERVISOR: Mr. GEORGIOS KATODRYTIS

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PROJECT REPORT

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ABSTRACT

A new method has been devised for the chemical synthesis of pure complex carbide phases and binary metal carbide powders in the Co-W-C ternary system.

Experimental quantities of Co_3W_3C an Co/WC has been produced with "nanoscale" microstructures.
The method consists of three main steps :

1) Design and synthesis of the mixed metal organic precursor.

2) Chemical reduction of the molecular precursor to yield a high surface area reactive intermediate of atomically mixed Co and W.
3) Reaction of the intermediate in a controlled activity environment to produce the desired and product eg. Co/WC or Co_3W_3C.

Introduction

Cemented carbides are a class of hard ,tough, wear resistant materials whose properties are between of tool steels and superhard ceramics. There properties are a compromise between hard properties of the carbide face and the ductile properties of the binder face.

These makes cemented carbides useful as tools for cutting metal and rock.

The mechanical properties of cemented carbide depend critically on its composition microstructure and the chemical purity of the carbide and metal powders from which the ceramic composite.

Tungsten carbide / Cobalt cermets consists of angular WC particles bonded with metallic Co. The average WC particle size ranges from the 10 μm to several 10 ths of a micro in the very fine grades. When decreasing WC particle size increase the hardness of the composite at the expence of lower mechanical shock resistance .

Increasing the volume fraction of Co increases the fracture toughness at the expence of hardness and wear resistance. Particle size is determined primarily by the mechanical crushing and milling steps in the conventional synthesis.

Nanoscale composite materials form a completely new untested class of particulate reinforce systems. Particulate reinforced composites they classified to two categories : Dispertion - Strengthened systems. Dispertion strengthened composites are characterised by particle diameters less than 0.1 micro, with matrix mean free paths less than 0.3 micro and volume fractions less than 15%. The matrix is the principal load bearing constituent in despertion - strengthened materials.

The particle strengthened composites are characterized by particle diameters grater than 1-micron with matrix mean free paths grater than 1-micron and volume fraction less than 25%. Nanoscale WC/Co shares the ultra-small particle and short mean free path characteristics of dispertion strengthened systems with the high volume fractions found in particle strengthened systems.

CHAPTER 1

STATE OF THE ART OF TUNGSTEN CARBIDE/COBALT TECHNOLOGY