

HIGHER TECHNICAL INSTITUTE
MECHANICAL ENGINEERING DEPARTMENT

DIPLOMA PROJECT

IMPROVEMENT OF THE WEAR RESISTANCE OF
METAL SURFACES

by
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M.Sc.

JUNE 1967

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OF METAL SURFACES

PROJECT NUMBER: M/801

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OF
METAL SURFACES

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PROJECT REPORT

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CONTENTS

CHAPTERS	TITLE	PAGES
	ACNOWLEDGEMENTS	3
	CONTENTS	
	ABSTRACT	4
	INTRODUCTION	5
CHAPTER 1	STATE OF THE ART OF TUNGSTEN CARBIDE/COBALT TECHNOLOGY	6
	1.1 CONVENTIONAL PROCESS	6
	1.2 SYNTHESIS BY GAS PHASE CARBURISATION OF MIXED OXIDES	7
CHAPTER 2	STATUS OF EXXON PROCESS	9
	2.1 PRECURSOR DESIGN AND SYNTHESIS	9
	2.2 NATURE OF REACTIVE INTERMEDIATE	9
	2.3 GAS PHASE CARBURIZATION	10
	2.4 CARBURIZATION KINETICS	12
	2.5 NANOSCALE WC/Co POWDER	12
	2.6 POWDER CONSOLIDATION	13
CHAPTER 3	PROPOSED CONTINUATION OF RESEARCH	14
	3.1 ON THE VALIDATION OF A STRENGTHENING CONCEPT (LOUAT THEORY)	14
	3.2 POWDER SYNTHESIS	18
	3.2.1 PRECURSOR SYNTHESIS	18
	3.2.2 PHASE EQUILIBRIA AND THERMODYNAMICS	19
	3.3 MATERIALS CHARACTERIZATION	21
	3.3.1 WEAR	21
	3.3.1.1 TYPES OF WEAR	21
	3.3.2 DESIGN FOR WEAR RESISTANCE	22
	3.3.3 MACHINABILITY	23
	3.3.4 HARDNESS TESTS	23
	3.3.5 IMPACT TESTS	23
CHAPTER 4	SPRAY DRYING AND ADVANTAGES	24
	4.1 SPRAY DRY EQUIPMENT AND PROCESS VARIABLES	24
	4.2 SPRAY DRYING ATOMIZATION SYSTEMS	24
	4.3 APPLICATIONS	25

	4.4	ATOMIZATION VARIABLES	25
	4.5	METAL POWDER EXPLOSIONS	26
CHAPTER	5	EXPERIMENTAL PROCEDURE	27
	5.1	TUBULAR FURNACE	27
		CONCLUSIONS	29
		REFERENCES	30
		APPENDICES	

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 $\text{Co}_3\text{W}_3\text{C}$ and 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 $\text{Co}_3\text{W}_3\text{C}$.

Introduction

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

This 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 consist of angular WC particles bonded with metallic Co. The average WC particle size ranges from the 10 μm to several 10ths of a micro in the very fine grades. When decreasing WC particle size increases the hardness of the composite at the expense of lower mechanical shock resistance.

Increasing the volume fraction of Co increases the fracture toughness at the expense 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 reinforced systems. Particulate reinforced composites are classified into two categories: Dispersion - Strengthened systems. Dispersion strengthened composites are characterized 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 dispersion - strengthened materials.

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

CHAPTER 1

STATE OF THE ART OF TUNGSTEN CARBIDE/COBALT TECHNOLOGY