

# CONTENTS

<i>Certificate</i> .....	i
<i>Approval Sheet</i> .....	ii
<i>Declaration</i> .....	iii
<i>Acknowledgement</i> .....	iv
<i>Abstract</i> .....	vi
<i>Contents</i> .....	x
<i>List of Figures</i> .....	xiii
<i>List of Tables</i> .....	xvi
<i>Nomenclature</i> .....	xvii

## 1. Chapter-1: Introduction

1.1 Overview.....	1
1.2 Properties of Titanium Carbide.....	2
1.3 Application of Titanium Carbide.....	8
1.4 Titanium Carbide Reinforced Composites.....	10
1.5 Aim of Present work.....	13
1.6 Lay out of the thesis.....	14

## 2. Chapter-2: Literature Survey

2.1 Preparation of Titanium Carbide (TiC) powder.....	15
2.2 Carbothermal reduction of Titanium Dioxide (TiO <sub>2</sub> ).....	19
2.3 Ilmenite as source of raw material.....	23
2.4 Carbothermal reduction of ilmenite.....	25
2.5 Plasma Technology.....	27
2.6 Thermal Plasma Synthesis of Ceramic Powders.....	30
2.7 Titanium Carbide Reinforced Aluminium Matrix Composite.....	33
2.8 Titanium Carbide Reinforced Polymer Matrix Composite.....	40
2.9 Scope of Present Work.....	47
2.10 Objectives.....	49

## 3. Chapter-3: Materials and Methods

3.1 Preparation of TiC powder.....	51
3.1.1 Raw materials.....	51
3.1.2 Description of the Extended Arc Thermal Plasma Reactor.....	53
3.1.3 Reduction of ilmenite in thermal plasma reactor.....	55
3.1.4 Acid leaching of the Plasma treated product.....	57
3.1.5 Removal of free carbon from the synthesized powder.....	57

3.2	Preparation of TiC reinforced Aluminium Matrix Composite.....	57
3.2.1	Raw materials.....	57
3.2.2	Fabrication of Al-TiC composite by Hot Pressing.....	58
3.3	Preparation of TiC reinforced Polymer Matrix Composite.....	60
3.3.1	Raw materials.....	60
3.3.2	Fabrication of composite by Hand Lay- up Technique.....	61
3.4	Characterization Methods.....	63
3.4.2	X-Ray Diffraction (XRD) Analysis.....	63
3.4.2	Scanning Electron Microscopy (SEM).....	63
3.4.3	Energy Dispersive X-ray (EDX) Analysis.....	64
3.4.4	Raman Spectroscopy.....	65
3.4.5	Particle size analysis.....	66
3.4.6	Density and Void Fraction Analysis.....	66
3.4.7	Nano-indentation Study.....	67
3.4.8	Compression Test.....	67
3.4.9	Test of Micro-Hardness.....	68
3.4.10	Erosion Wear Test.....	70
3.4.10.1	Erosion Test Apparatus.....	70
3.4.10.2	Taguchi Experimental Design.....	72

#### **4. Chapter 4: Results and Discussions Part-I**

4.1	Thermo chemistry.....	75
4.2	Analysis of Raw Materials.....	76
4.2.1	X ray Diffraction Analysis.....	76
4.2.2	Scanning Electron Microscopy.....	77
4.3	Characterization of the Plasma Treated Product.....	78
4.3.1	X-Ray Diffraction Analysis.....	78
4.3.2	Micro Structural Analysis.....	79
4.4	Characterization of the Synthesized TiC Powder.....	82
4.4.1	X-Ray Diffraction Analysis.....	82
4.4.2	Micro structural Analysis.....	83
4.4.3	Raman Spectroscopy.....	84
4.4.4	Particle Size Analysis.....	85
4.5	Summary.....	86

#### **5. Chapter 5: Results and Discussions Part-II**

5.1	Characterization of the Al-TiC composite.....	88
5.1.1	Density and Void Fraction Analysis.....	88
5.1.2	X-Ray Diffraction Analysis.....	89
5.1.3	Micro structural Analysis.....	90

5.1.3.1	Field Emission Scanning Electron Microscopy (FESEM).....	90
5.1.3.2	Energy Dispersive X-ray (EDX) Analysis with Compositional Mapping.....	91
5.2	Mechanical Characterization.....	95
5.2.1	Nano-indentation Study.....	95
5.2.1.1	Young's Modulus.....	95
5.2.1.2	Vickers Hardness.....	96
5.2.1.3	Load vs. Displacement curve.....	97
5.2.2	Compression Test Data.....	97
5.3	Summary.....	98
<b>6.</b>	<b>Chapter 6: Results and Discussions Part-III</b>	
6.1	Characterization of TiC filled Glass-Epoxy composite.....	100
6.1.1	Density and void fraction Analysis.....	100
6.1.2	Micro-Hardness.....	101
6.2	Solid Particle Erosion Behaviour.....	102
6.2.1	Taguchi Analysis of the Erosion Test Results.....	102
6.2.2	Steady State Erosion Rate.....	106
6.2.3	Surface Morphology.....	107
6.3	Summary.....	111
<b>7.</b>	<b>Chapter 7: Conclusions</b>	
7.1	Conclusions.....	112
7.2	Future Scope of Work.....	113
<b>8.</b>	<b>Reference.....</b>	<b>114-131</b>
<b>9.</b>	<b>List of publications.....</b>	<b>132</b>