

CONTENTS

	Page
1 CARBON-CARBON OVERVIEW	1
Introduction	1
Carbon Fibers	4
Continuous Fiber Composites	6
Chemical Vapor Deposition	7
Carbonized Organic Composites	9
Mechanical Properties	11
Applications	12
Conclusions	14
References	14
Bibliography	17
2 CARBON FIBER MANUFACTURING	19
Introduction	20
Manufacture of PAN-Based Carbon Fibers	20
Manufacture of Rayon-Based Carbon Fibers	26
Manufacture of Pitch-Based Carbon Fibers	27
Manufacture of Vapor-Grown Carbon Fibers	33
Mechanical Properties of Carbon Fibers	35
Summary	37
References	37
3 EFFECT OF MICROSTRUCTURE AND SHAPE ON CARBON FIBER PROPERTIES	41
Introduction	42
Carbon Fiber Processes	43
Effect of Graphite Structure on Fiber Properties	44
Brittle Failure Mechanism	45
Microstructure of Carbon Fibers	47
Effect of Microstructure on Fiber Properties	53
Effect of Fiber Shape on Fiber and Composite Properties	61
Summary	66
References	67
4 TEXTILE PREFORMS FOR CARBON-CARBON COMPOSITES	71
Introduction	72
Classification of Preforms	72
Linear Fibrous Assemblies	74
Fabric Preforms	75
Modeling of Textile Structural Composites	93
Concluding Remarks	99
References	100
Bibliography	104
5 CARBON-CARBON MATRIX MATERIALS	105
Introduction	106
Carbon Fibers	108
Fabrication Methods of CC Composites	111
Matrix Inhibition	121
Microstructural Characterization Techniques	123
Microstructure of CC Matrices	127
Influence of Matrix on Composite Properties	149

References	158
6 MECHANICS OF MULTIDIRECTIONAL CARBON-CARBON COMPOSITE MATERIALS	169
Symbols	170
Introduction	170
Background	172
Characteristics of CC Materials	175
Description of Model	176
Method of Analysis	179
Multidirectional Composite Model	179
Degraded Properties Model	181
Thin CC Composites	182
Property Predictions and Data Correlation	183
Effects of Degraded Properties	188
Concluding Remarks	191
References	193
7 MANUFACTURING AND DESIGN OF CARBON-CARBON COMPOSITES	
Introduction	
Composite Design	
Carbon-Carbon Composite Densification	
References	
8 HIGH-TEMPERATURE COATINGS ON CARBON FIBERS AND CARBON-CARBON COMPOSITES	223
Introduction	225
High-Temperature Coatings on Carbon Fibers	226
High-Temperature Coatings on CC Composites	239
References	256
9 APPLICATIONS OF CARBON-CARBON	267
References	280