

Index

List of Abbreviations	xi
List of Symbols	xii
1 Introduction	1
2 Fibre-Reinforced Polymers and Nanoparticles	5
2.1 Structure and Properties of Fibre-Reinforced Polymers	5
2.1.1 Carbon Fibre	5
2.1.2 Epoxy Matrix	6
2.1.3 Prepregs	7
2.1.4 Mechanical Behaviour Under Loading	9
2.2 Structure and Properties of Carbon Nanoparticles	15
2.2.1 Graphene	16
2.2.2 Carbon Nanotubes	17
2.3 Nanoparticle-Modified Fibre-Reinforced Polymers	18
3 Material and Experimental Methods	21
3.1 Materials used in this Work	21
3.2 Manufacture of Nanoparticle-Modified Fibre-Reinforced Composites	22
3.2.1 Nanoparticle Dispersion	22
3.2.2 Prepreg Production	22
3.2.3 Laminate Lay-up and Cure	24
3.2.4 Specimen Preparation	25
3.3 Manufacture of Nanoparticle-Epoxy Resin Composites	26
3.4 Methods of Material Characterisation	27
3.4.1 Glass Transition Temperature and curing enthalpy	27
3.4.2 Fibre Volume Content	27
3.4.3 Optical Light Microscopy	27
3.4.4 Optical Stress Analysis	28
3.4.5 Acoustic Emission Analysis	29

3.4.6	Thermography.....	30
3.4.7	X-ray Analysis.....	30
3.4.8	Scanning Electron Microscopy.....	31
3.5	Mechanical Testing.....	31
3.5.1	Quasi-Static Tensile Tests.....	31
3.5.2	Fatigue Loading.....	32
3.5.3	Mode I Fracture Test: Double Cantilever Beam.....	33
3.5.4	Mode II Fracture Test: End Notched Flexure.....	34
4	Results and Discussion.....	35
4.1	Material Characterisation.....	35
4.2	Mechanical Properties.....	36
4.3	Fatigue Life and Degradation.....	39
4.3.1	Tension-Tension Regime.....	39
4.3.2	Tension-Compression Regime.....	47
4.4	Interlaminar Fracture Toughness in Mode I and II.....	55
4.5	Damage Mechanisms and the Effect of Nanoparticles.....	60
4.5.1	Energy Dissipation Mechanisms of Carbon Nanoparticles.....	60
4.5.2	Influence of Carbon Nanoparticles on Matrix Crack Initiation and Propagation.....	66
4.5.3	Loading Mode Dependent Behaviour of Carbon Nanoparticles.....	78
4.5.4	Mechanism Based Models of Damage Development.....	85
5	Summary.....	91
6	Conclusion.....	95
7	Outlook.....	97
	References.....	99
	Curriculum Vitae.....	108