

Table of Contents

LIST OF FIGURES.....	17
LIST OF TABLES.....	21
Chapter I. “State of the Art” related to the approached subject.	23
I.1. Designing hybrid polymer composite materials.	25
I.2. Material properties of hybrid polymer composites.....	29
I.2.1. Mechanical properties of hybrid composites.	32
I.2.2. Dynamic mechanical properties of hybrid composites	36
I.2.3. Thermo-physical properties of hybrid composites.	38
I.2.4. Electrical properties of hybrid composites.....	43
I.3. General remarks.	47
Chapter II. Objectives.	49
II.1. Research general objectives.	51
II.2. Research specific objectives.	52
Chapter III. Design of Experiments.	55
III.1. Introduction.....	57
III.2. Hybrid polymer based composites - architectures and synthesis.	57
III.2.1. Types of constitutive.....	58
III.2.2. Manufacturing of composite stacking.	60
III.3. Testing methodologies and equipments.	64
III.3.1. Mechanical properties.....	64
III.3.2. Dynamic mechanical thermal characterization.....	64
III.3.3. Thermo-physical properties.....	65
Thermal expansion.	65
Thermal conductivity.	65

III.3.4. Thermal stability and fire retardant properties.	65
III.3.5. Dielectric properties.....	66
III.3.6. Scanning electron microscopy (SEM).	66
III.3.7. General considerations and specifications.....	66

Chapter IV. Theoretical Micromechanical based Approaches..... 69

IV.1. Introduction.....	71
IV.2. Effective elastic modulus.....	73
IV.3. Effective complex elastic modulus.	76
IV.4. Effective thermal properties.....	78

Chapter V. Effective measured properties. Results and discussion... 79

V.1. Mechanical properties.....	81
V.1.1. Effect of hybridization on effective flexural properties.	81
V.1.2. RoM or RoHM vs. experimental data.....	85
V.2. Dynamic mechanical properties	89
V.2.1. Epoxy based composites.....	90
<i>Storage modulus (E')</i>	90
<i>Damping factor/loss tangent (tan δ)</i>	92
<i>Cole-Cole plots</i>	98
V.2.2. Epoxidized linseed oil based composites.....	100
<i>Storage modulus (E')</i>	100
<i>Damping factor/loss tangent (tan δ)</i>	102
<i>Cole-Cole plots</i>	103
V.3. Thermo-physical properties.....	104
V.3.1. Thermal expansion.	104
V.3.2. Thermal conductivity.....	105
<i>Epoxy based composites</i>	105

<i>ELO based composites</i>	107
V.4. Morphology of composites.	108
Chapter VI. Effects of fiber orientation and content on the mechanical properties of multi-layered glass/carbon fiber reinforced polymer composites.	111
VI.1. Introduction.	113
VI.2. Experimental research.	116
VI.2.1. Materials selection and specimens preparation.....	116
VI.2.2. Material testing procedures.....	116
VI.3 Results and discussion.	118
VI.3.1 Mechanical properties.	118
VI.3.2. Dynamic mechanical thermal analysis (DMA)	120
VI.3.3 Thermo-mechanical analysis (CTE).....	128
VI.4. Conclusions.	130
Chapter VII. Conclusions on the original work.	133
VII.1. Global conclusions.	135
VII.1.1. Mechanical properties of hybrid polymer composites.....	135
VII.1.2. Dynamic mechanical properties of hybrid polymer composites.....	137
VII.1.3. Thermo-physical changes of hybrid polymer composites.....	139
VII.1.4. Electrical properties of hybrid polymer composites.....	142
Chapter VIII. Future research lines.	143
VIII.1. Directions of scientific research.	145
VIII.1.1. Beyond the ‘state-of-the-art’ of physical and mechanical properties of hybrid composites.	145
VIII.1.2. Beyond the ‘state-of-the-art’ of dynamical mechanical properties of hybrid composites.....	146

VIII.1.3. Beyond the ‘state-of-the-art’ of thermal properties of hybrid composites	146
VIII.1.4. Beyond the ‘state-of-the-art’ of electrical properties of hybrid composites.	147
VIII.1.5. Beyond the ‘state-of-the-art’ of all effective material properties of hybrid composites.....	148
References.	151