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APPENDIX A

Aniline-based Benzoxazine Resin and Novolac Epoxy Characterization.

Appendix A-1 Liquefying and gel temperature at 500 Pa.s of aniline-based benzoxazine resins mixed with novolac epoxy resin.

Benzoxazine : Epoxy	Rheometer	
	Liquefying temperature (°C)	Gel temperature (°C)
100 : 00	66	200
80 : 20	67	206
60 : 40	85	213
40 : 60	88	222

Appendix A-2 Softening point (Tg of resin) and curing temperature of aniline-based benzoxazine resins mixed with novolac epoxy resin.

Benzoxazine : Epoxy	Differential Scanning Calorimeter (DSC)	
	Softening point (°C)	Curing temperature (°C)
100 : 00	47	230
80 : 20	51	235
60 : 40	58	242
40 : 60	63	250

APPENDIX B

Characterization of Aniline-based Benzoxazine Resin and Novolac Epoxy Copolymers.

Appendix B-1 The density of aniline-based benzoxazine resins mixed with novolac epoxy resin.

Benzoxazine : Epoxy	Density (g/cm^3)	
	Theorem	Actual
100 : 00	1.1850	1.1851
80 : 20	1.1860	1.1862
60 : 40	1.1870	1.1872
40 : 60	1.1879	1.1875

Appendix B-2 Glass transition temperature (T_g) and storage modulus at room temperature (E') of aniline-based benzoxazine resins and novolac epoxy copolymers.

Benzoxazine : Epoxy	Dynamic mechanical analysis (DMA)		
	First T_g (°C)	Second T_g (°C)	E' (GPa)
100 : 00	168	168	5.99
80 : 20	164	112	5.28
60 : 40	145	118	4.88
40 : 60	115	115	4.72

Appendix B-3 Coefficient of thermal expansion (CTE) of aniline-based benzoxazine resins and novolac epoxy copolymers.

Benzoxazine : Epoxy	Coefficient of thermal expansion (CTE), ppm/°C	
	CTE at 30-120°C	CTE at 170-250°C
100 : 00	46.80	-
80 : 20	23.47	99.99
60 : 40	20.97	39.52
40 : 60	33.84	33.84

Appendix B-4 Degradation temperature (T_d) at 5% weight loss and residue weights (char yield) at 800°C of aniline-based benzoxazine resins and novolac epoxy copolymers.

Benzoxazine : Epoxy	Thermogravimetric analyzer (TGA)	
	T_d (°C)	Char yield (%)
100 : 00	329	32.5
80 : 20	342	30.0
60 : 40	350	28.5
40 : 60	362	25.5

Appendix B-5 Flexural strength and Flexural Strain of aniline-based benzoxazine resins and novolac epoxy copolymers.

Benzoxazine : Epoxy	Flexural Properties		
	Strength (MPa)	Modulus (GPa)	Strain (%)
100 : 00	114.59	4.7	2.07
80 : 20	128.91	4.6	2.34
60 : 40	142.46	4.4	2.80
40 : 60	157.93	4.5	3.73

Appendix B-6 Water adsorption of aniline-based benzoxazine resins and novolac epoxy copolymers.

Benzoxazine : Epoxy	Water adsorption (%)
100 : 00	0.11
80 : 20	0.12
60 : 40	0.10
40 : 60	0.10

Appendix B-7 Hardness (Shore D) of aniline-based benzoxazine resins and novolac epoxy copolymers.

Benzoxazine : Epoxy	Hardness (Shore D)
100 : 00	91
80 : 20	91
60 : 40	90
40 : 60	90

APPENDIX C

Characterization of Fiber Glass-reinforced (E-glass) Polybenzoxazine/Epoxy Copolymers Composite.

Appendix C-1 The density of fiber glass-reinforced polybenzoxazine and novolac epoxy copolymers composite.

Benzoxazine : Epoxy	Density (g/cm^3)	
	Theorem	Actual
100 : 00	2.2690	1.9435
80 : 20	2.2692	1.9547
60 : 40	2.2694	1.9430
40 : 60	2.2695	1.9471

Appendix C-2 Coefficient of thermal expansion (CTE) of fiber glass-reinforced polybenzoxazine and novolac epoxy copolymers composite.

Benzoxazine : Epoxy	Coefficient of thermal expansion (CTE), ppm/°C	
	CTE at 30-120°C	CTE at 170-250°C
100 : 00	24.26	103.01
80 : 20	23.77	100.23
60 : 40	20.97	39.95
40 : 60	33.84	33.84

Appendix C-4 Flexural strength and Flexural Strain of aniline-based benzoxazine resins and novolac epoxy copolymers.

Benzoxazine : Epoxy	Flexural Properties		
	Strength (MPa)	Modulus (GPa)	Strain (%)
100 : 00	241.82	18.7	1.75
80 : 20	358.00	21.6	2.22
60 : 40	416.00	22.2	2.32
40 : 60	378.00	21.1	3.01

Appendix C-5 Water adsorption of fiber glass-reinforced polybenzoxazine and novolac epoxy copolymers composite.

Benzoxazine : Epoxy	Water adsorption (%), 24 hours.
100 : 00	1.83
80 : 20	1.60
60 : 40	1.67
40 : 60	1.35

Appendix C-6 Hardness (Shore D) of fiber glass-reinforced polybenzoxazine and novolac epoxy copolymer composite.

Benzoxazine : Epoxy	Hardness (Shore D)
100 : 00	85
80 : 20	88
60 : 40	93
40 : 60	90

VITAE

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