

CHARACTERIZATION OF METAL MATRIX COMPOSITES

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INTRODUCTION TO METAL MATRIX COMPOSITES

Metal Matrix Composites:

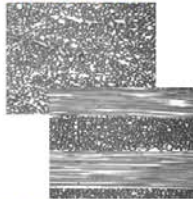
- Al₂O₃ Fiber
- 6061-T6 Al Matrix

Uses:

- Wide Variety of Commercial and Military Applications
- Applications that require high compressive strength

Goal:

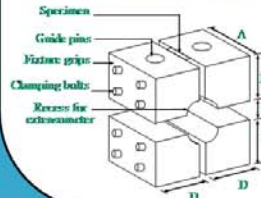
- Determine Sample and Tab Geometry, to obtain gauge section failures in cross-ply laminates with high percentage of 0° layers



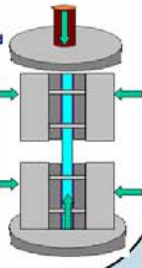
TEST METHOD

Combined Loading Compression (CLC):

- Applies both End and Shear Loading
- End Tab and Adhesive Failure less likely than with ITTR Method
- Machining requirements higher than with ITTR Method

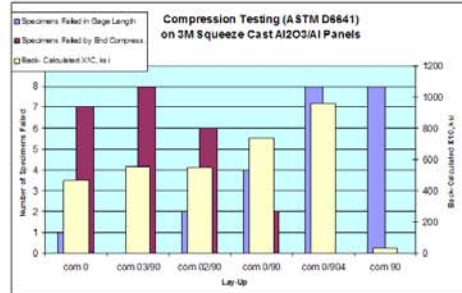


Dimension	in	mm
A	2.1	53
B	2.5	64
C	0.5	12.7
D	1.9	48



TEST RESULTS - COMPRESSION

	com 0	com 0/90	com 0/90	com 0/90	com 0/90	com 90	com 45
Compressive UL Strength, psi	Avg. 4.09E+05	4.24E+05	3.75E+05	3.89E+05	2.98E+05	6.00E+04	3.89E+04
St Dev	-	2.94E+04	3.93E+02	5.19E+04	2.77E+04	6.48E+03	7.67E+02
Compression Modulus, Msi	Avg. 39.17	32.84	29.39	31.80	21.98	24.55	19.33
St Dev	1.67	0.87	1.95	0.64	0.98	2.38	0.32
Valid specimens for strength/modulus	95 (2)	88	85	38	38	35 (3)	44
Calculated modulus, Msi (%)	36.5	32.3	31.0	26.1	23.1	19.7	-
Specimens Failed in Gauge Length (%)	12.5	0	25.0	50	100	100	100



TEST RESULTS: TENSION

Specimen #	Specimen ID	Width (in.)	Thickness (in.)	Max. Load (lb)	ULM Strength (psi)	Young's Modulus (Msi)	Poisson's Ratio	ULM Strain (microstrain)	Failure
1	121702-1-15Sample#I	0.425	0.105	6676	1.50E+05	3.07E+01	-	4.13E+03	in lab
2	121702-1-15Sample#F	0.427	0.105	7224	1.67E+05	3.00E+01	-	3.24E+03	in lab
3	121702-1-15Sample#G	0.428	0.105	6167	1.37E+05	3.46E+01	2.79E-01	4.69E+03	in lab
4	121702-1-15Sample#H	0.429	0.105	7671	1.57E+05	3.46E+01	2.80E-01	4.69E+03	in lab
5	121702-1-15Sample#J	0.428	0.105	5539	1.23E+05	3.24E+01	2.79E-01	3.89E+03	in lab
Average	0.427	0.105	-	1.48E+05	3.38E+01	2.79E-01	4.04E+03	-	
Standard Dev	0.001	0.000	-	1.59E+04	2.30E+00	9.33E-04	5.22E+02	-	
Coef of Var (%)	0.3	0.0	-	10.8	6.8	0.3	12.9	-	

Specimen #	Specimen ID	Width (in.)	Thickness (in.)	Max. Load (lb)	ULM Strength (psi)	Young's Modulus (Msi)	Poisson's Ratio	ULM Strain (microstrain)	Failure
2	121702-2-15Sample#I	0.425	0.105	2897	4.69E+04	2.42E+01	-	2.23E+03	gauge length
3	121702-2-15Sample#H	0.427	0.105	2928	4.70E+04	2.51E+01	-	2.17E+03	gauge length
4	121702-2-15Sample#G	0.428	0.105	6198	4.29E+04	2.74E+01	1.34E-01	1.72E+03	gauge length
5	121702-2-15Sample#F	0.427	0.105	2246	5.98E+04	2.52E+01	1.52E-01	2.31E+03	gauge length
121702-2-15Sample#E	0.425	0.105	1889	4.23E+04	2.42E+01	-	1.92E+03	gauge length	
Average	0.427	0.105	-	4.59E+04	2.43E+01	1.45E-01	2.10E+03	-	
Standard Dev	0.001	0.000	-	1.59E+04	1.47E+00	1.52E-02	2.22E+02	-	
Coef of Var (%)	0.2	0.0	-	7.3	6.0	10.6	10.8	-	

FIBER VOLUME FRACTION

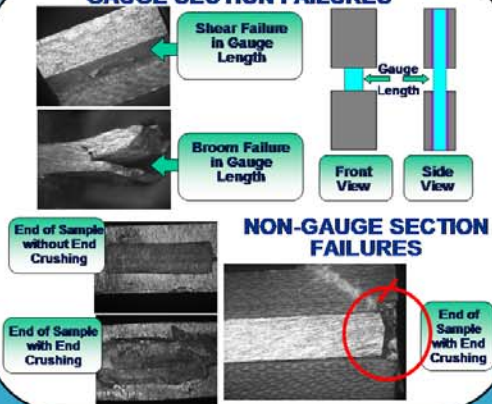
$$\frac{\delta_c - \delta_m}{\delta_f - \delta_m} \times 100 = \% V_f$$

δ_c : Density of Composite
 δ_m : Density of Matrix
 δ_f : Density of Fibers
 V_f : Volume Fraction

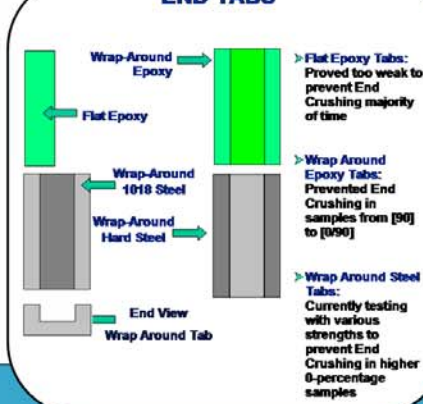
Plate	δ_c (g/cc)	%V _f from Low δ_m	%V _f from High δ_m	%V _f from Average δ_m
0-3-2	3.2862	67.88	47.36	63.26
121702-1-1	3.5150	72.75	67.38	70.83
0009030	3.3574	65.26	56.57	61.40
0131003-1-1	3.4888	71.85	64.82	68.73
121202-2-1	3.5186	74.01	67.51	71.12
112502-3-2	3.4891	72.68	65.75	69.58
112502-3-1	3.4834	71.46	64.33	68.29
112502-2-2	3.6177	73.65	67.06	70.72
121602-1-1	3.5349	75.18	68.98	72.42
121602-1-2	3.5841	79.86	76.30	78.06
112502-2-1	3.4751	70.86	63.58	67.63
0009030	3.4844	71.54	64.42	68.38
112501-1-2	3.5836	72.83	66.36	69.92
0009030	3.4163	66.62	58.28	62.91
0903A	3.4880	71.80	64.74	68.66
0903C	3.4202	66.98	58.63	63.22
013103-1-1	3.4684	70.45	63.67	67.17
121802-2-1	3.4701	70.59	63.32	67.22
Average	3.4701	70.57	63.24	67.38
Standard Deviation	0.114	5.17	4.88	4.88

* Low δ_m : 2.6934 g/cc High δ_m : 2.7705 g/cc
Average δ_m : 2.6320 δ_f : 3.8787 g/cc

GAUGE SECTION FAILURES



END TABS



ACKNOWLEDGEMENTS

CMT
 Dr. Ian Hall
 Dr. Travis Bogetti
 Dr. Antonio Paesano
 Art Yiourmas
 Touy Thiravong
 Frank Kriss

